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ENVIRONMENTAL DESCRIPTIONS OF RANGER TRAINING AREAS. Part 2. Eglin Field Area, Florida.

The University of Tennessee
31 August 1964

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To: The Director, WES
Attention: WESSE

From: E. Carl Shreve
Project Coordinator

Subject: Contract No. DA-22-079-eng-333. Sponsored by Army Materiel Command Project No. 1-T-0-21071-A-131.

It is a pleasure to submit herewith the report on "Environmental Descriptions of Ranger Training Areas, Part 2. Eglin Field Area, Florida." The University of Tennessee Group to which this study was assigned appreciates the support and encouragement given by the United States Army Materiel Command and the Corps of Engineers, Waterways Experiment Station.

Respectfully submitted,

E. Carl Shreve

E. Carl Shreve

Department of Civil Engineering
The University of Tennessee

ENVIRONMENTAL DESCRIPTIONS

OF

RANGER

TRAINING AREAS

Part 2. Eglin Field Area, Florida

Area Evaluation Section, Embankment and Foundation Branch,

Soils Division

U. S. Army Waterways Experiment Station, Corps of Engineers

Vicksburg, Mississippi

Contract No. DA-22-079-eng-333

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Department of Civil Engineering

The University of Tennessee

Knoxville, Tennessee

31 August 1964

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ENVIRONMENTAL DESCRIPTIONS OF RANGER TRAINING AREAS

PART 2. EGLIN FIELD, FLORIDA

I. INTRODUCTION

A. Report Coverage

This report represents the continuation of a University of Tennessee study begun in June, 1962 and supported by the Waterways Experiment Station, Corps of Engineers, Vicksburg, Mississippi as part of the U. S. Army Research and Development Board Project MEGA. The purpose and scope of the investigation were outlined in Environmental Descriptions of Ranger Training Areas. Part 1. Mountain Training Area, North Georgia, Department of Civil Engineering, University of Tennessee, June 1, 1963. The Ranger training area at Eglin Field, Florida, selected for the second phase of the investigation, is described in the present report. Macrogeometric and vegetational data compiled in the study are plotted on areal maps on a scale of 1:50,000.

B. Location

The Eglin Field training area of the U. S. Army Rangers is mainly located in adjoining portions of southeastern Santa Rosa County and southwestern Okaloosa County in the westernmost section of the Florida Panhandle (Figure 1). Included in the area is a segment of Santa Rosa Island, a southeastern projection of Escambia County. The

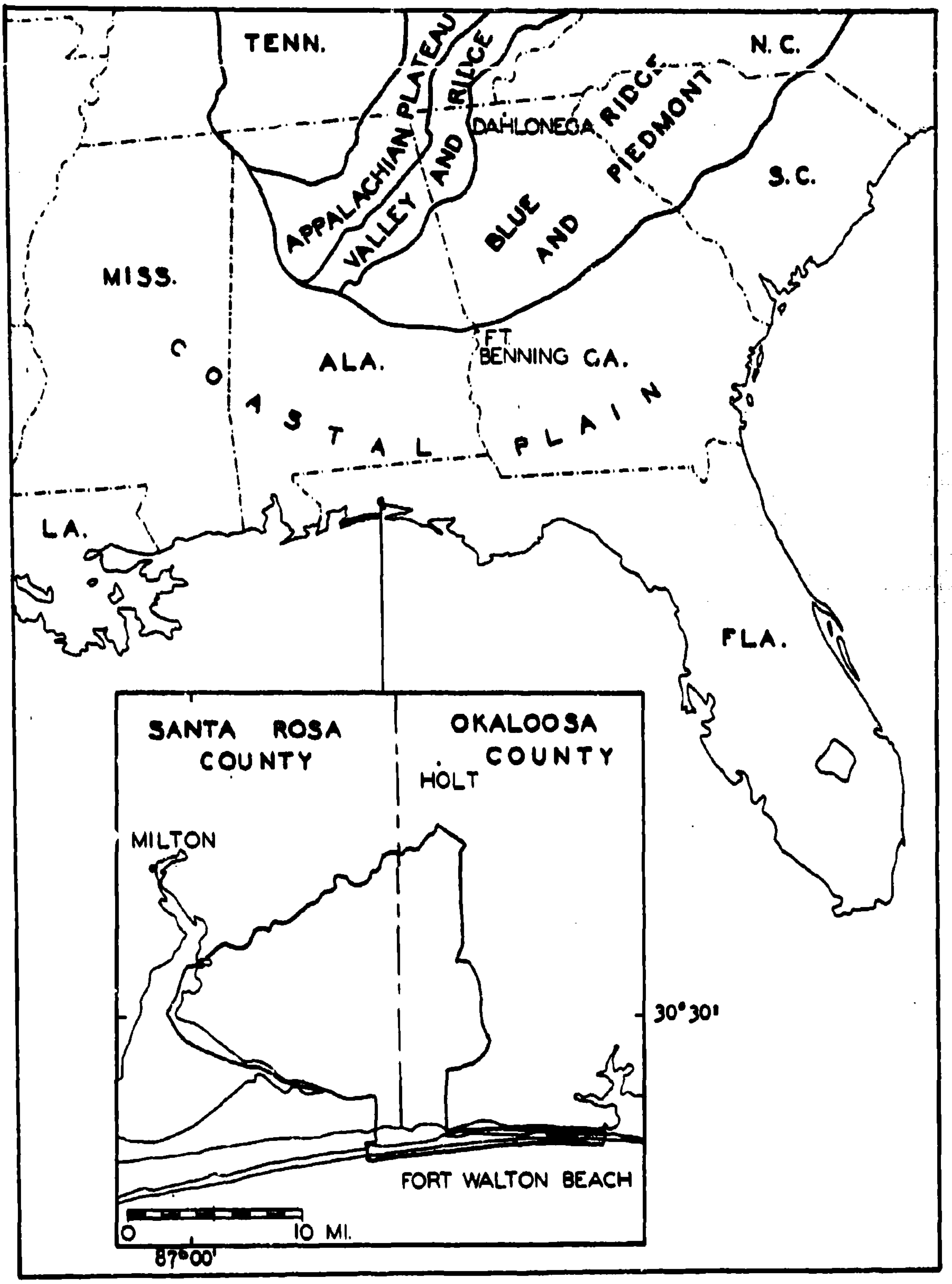


Figure 1. Regional setting and location of the Eglin Field area, Florida.

area lies east and southeast of Milton, Santa Rosa County, south and southwest of Holt, Okaloosa County, and west, northwest, and southwest of Fort Walton Beach, Okaloosa County. The training area lies between longitudes 86° 36' 31" W and 87° 01' 15" W and latitudes 30° 22' 40" N and 30° 40' 23" N, covering approximately 200 square miles within those boundaries.

The Eglin area is located near the seaward margin of the emerged coastal plain surface in the northeastern section of the Gulf segment of the Coastal Province (Murray, 1961). Principal access to the area is provided by military and forestry roads leading from State Highway 87, which crosses the western part of the area in a north-south direction, and from U. S. Highway 98, which crosses the southern part of the area as it extends westward from Fort Walton Beach to Pensacola.

The area is included on portions of Army Map Service Series V 747 topographic maps 3545 II, Edition 1 (Milton); 3645 III, Edition 1 (Harold); 3645 II, Edition 3 (Holt); 3544 I, Edition 1 (Pensacola); 3644 IV, Edition 1 (Holley); and 3644 I, Edition 2 (Fort Walton Beach [Mary Esther]). On these maps, vertical (west to east) grid lines 98 to 38 and horizontal (south to north) grid lines 60 to 94 enclose the area and provide a co-ordinate reference system.

C. Personnel

Professors E. Carl Shreve, Department of Civil Engineering,

project co-ordinator, and Fred H. Norris, Department of Botany, and R. E. McLaughlin, Department of Geology and Geography, supervising consultants, served in the same capacities and contributed to the various aspects of the study and report as detailed in Part 1.

Professor D. C. Jameson, Jr., Department of Civil Engineering, Professor Franklin Robinson of Hiwassee College, and Mr. C. James Dunigan, Department of Geology and Geography, participated in the collection of field data, assisted by Daryl Armentrout, Sam Keener, and Douglas Murray, students in the Department of Civil Engineering.

In the compilation of this report, project personnel contributed in the same manner as before with Mr. Dunigan extending the statistical analysis of data substantially and assisting in the supervision of the cartographic presentation.

D. Acknowledgments

Without the co-operation and assistance of Lieutenant Colonel R. E. Hakala, Commanding Officer, and Captains Lynn Steverson and P. F. Keefe at the Ranger training camp, the investigation of the Eglin Field area could not have been accomplished. Their support is gratefully acknowledged.

Mr. E. E. Addor and Mr. Robert Temple of the Waterways Experiment Station, Vicksburg, Mississippi, visited the study area during the course of the field survey and supplied valuable assistance and technical

advice. Mr. Addor and Mr. Warren E. Grabau, Chief of the Area Evaluation Section, were especially helpful in providing critical guidance at various stages of the investigation.

II. PHYSICAL DESCRIPTION OF THE EGLIN FIELD AREA

A. Physiography

The gulfward portion of the Eglin Field Ranger training area lies within the Coastal Lowlands (Cooke, 1939) or Terraced Coastal Lowlands (Vernon, 1951) topographic division of Florida (Figure 2). In the terminology of Cooke, the region north of East Bay River is part of the Western Highland division. The Gulf of Mexico on the south and the East Bay and Blackwater Bay lobes of Pensacola Bay on the west form salt water boundaries. Liveoak Creek, Metts Creek, and the upland divide separating them approximate the eastern boundary of the area. The north bank of the Yellow River constitutes a northeast-southwest trending enclosure.

The area can be subdivided into six natural physiographic subdivisions from south to north as follows;(Figure 3):

<u>Santa Rosa Island</u>. The island is a recent offshore or barrier bar, approximately 88 km. long by .8 km. wide, terminating to the east in Choctawhatchee Bay and to the west in Pensacola Bay. The Ranger area includes a 23 km. strip of this elongate island, which has an even, slightly curved coastal shoreline and a crenulate intracoastal margin. Both margins are characterised by sand dunes (Figure 4) reaching heights of approximately 15 1/4 meters.

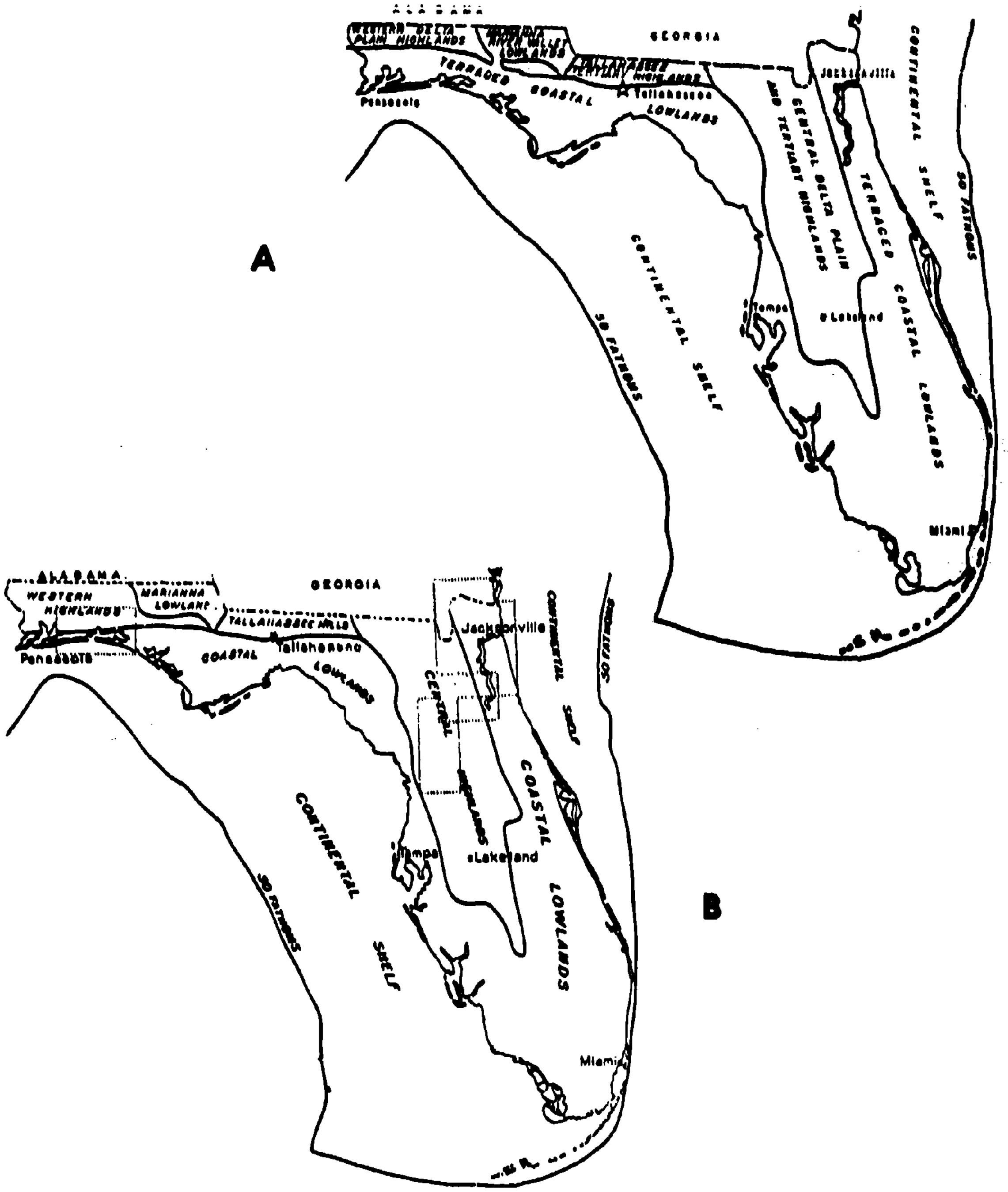


Figure 2. Topographic divisions of Florida. A. After Vernon, 1951. B. After Cooke, 1939.

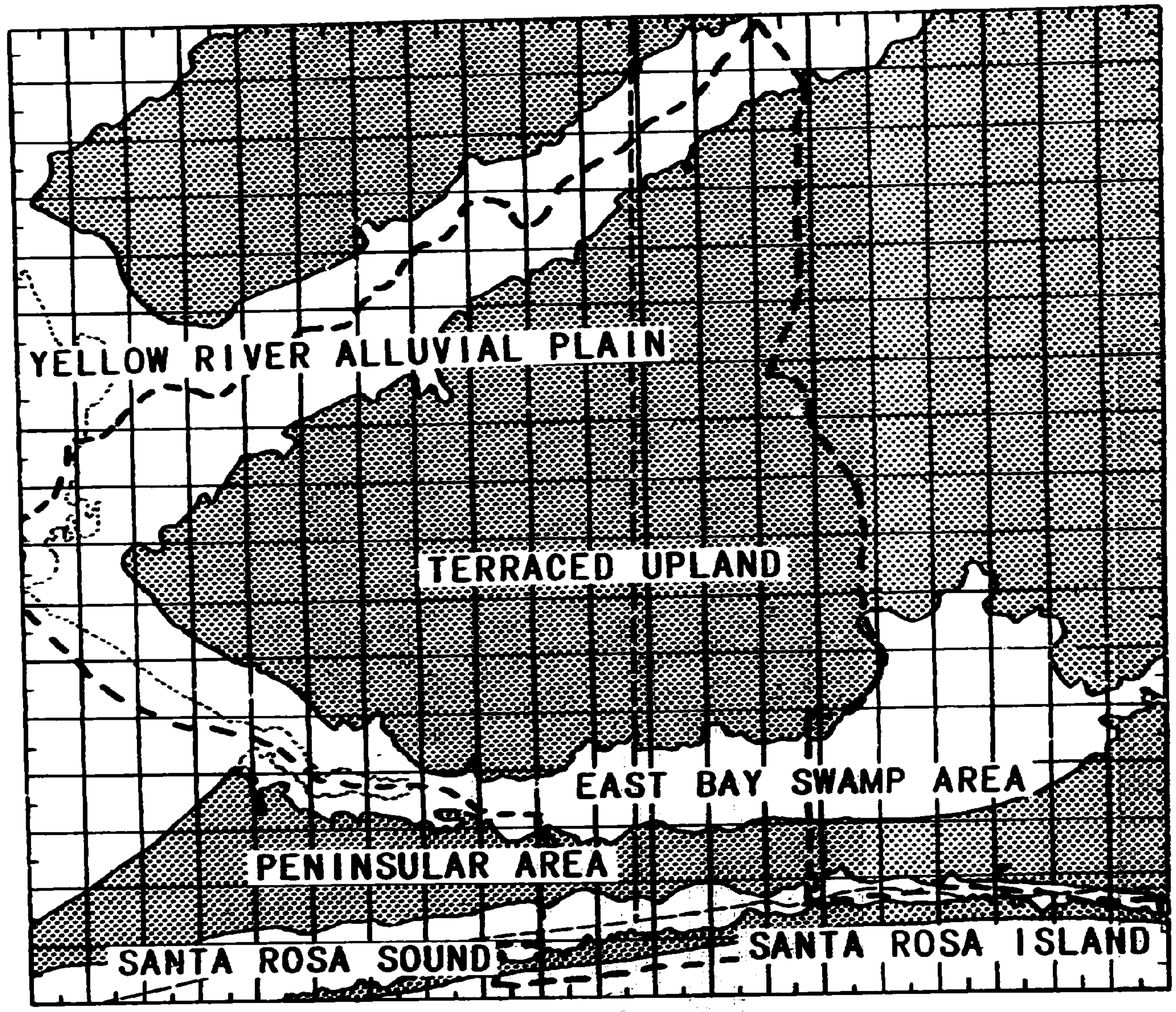
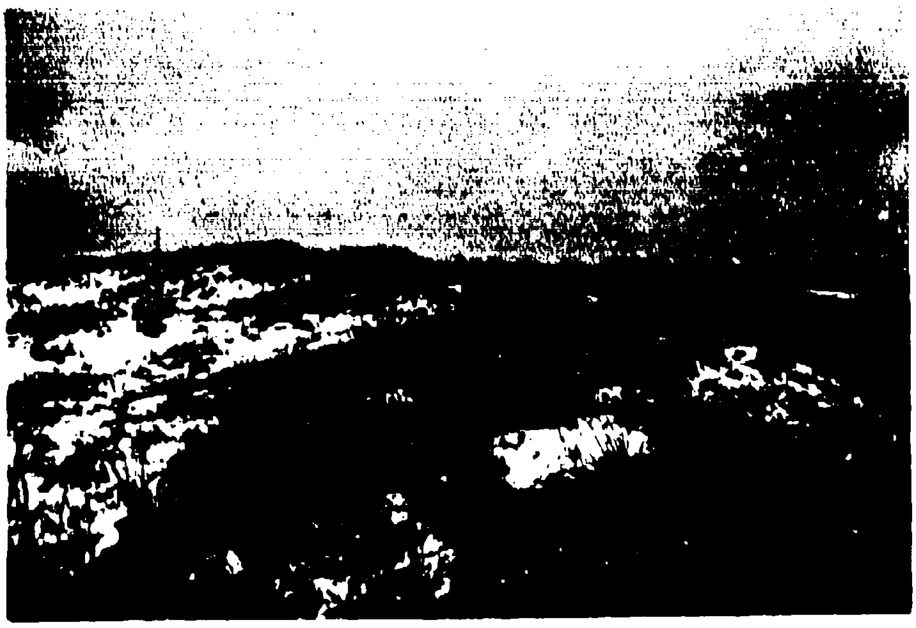


Figure 3. Physiographic subdivisions of the Eglin Field area.

A



B

Figure 4. Major relief features on Santa Rosa Island. A. Dune. B. Gulf-facing transverse ridge.

Equally high beach ridges are largely confined to the seaward margin, along which orientation of both features parallel to the shore is more uniform. The major portion of the island is a relatively flat inner area less than six meters above sea level that is scalloped by numerous swales (Figure 5)..

__Santa Rosa Sound__. The sound is an open lagoon lying between the main coast and the island with which it is genetically related (Figure 6). The sound is a section of the Inter-coastal Waterway between Fort Walton Beach and the eastern margin of Pensacola Bay.

__Peninsular Area__. Extending from Fort Walton Beach westward, this broad to narrow coastal belt forms the mainland shore of Santa Rosa Sound to the south and is ultimately atten-uated into a bay-mouth bar nearly across Pensacola Bay. This area has a complex geomorphic structure consisting basically of a Pleistocene (Late Wisconsin) offshore bar with a tombolo-like connection with the mainland west of Fort Walton Beach. This peninsula is surfaced by one or two of the youngest marine terraces developed through eustatic changes in sea level during alternating glacial and interglacial stages. This predominantly flat area

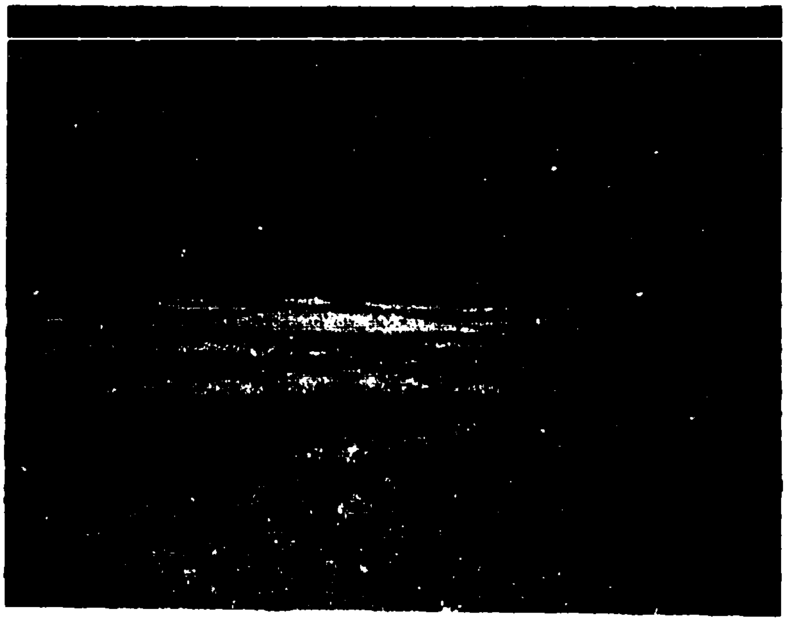


Figure 5. Central swale area, Santa Rosa Island.

Figure 6. Santa Rosa Sound. Typical leeward promonotory on Santa Rosa Island in the foreground.

averages little more than 9 meters in elevation. Fringing the "fossil" bar proper are tidal sediments which have altered the original outline. On the leeward size, sedimentary fill and swamp development have obscured the associated lagoon except for the tidal inlet or estuary projecting eastward from East Bay past Miller Point. A narrow strip, a little over 9 km. wide, crossing this physiographic subdivision is included in the Ranger area.

East Bay Swamp Area. According to the preceding interpretation of the origin of the Peninsular Area, the East Bay Swamp Area is largely a filled lagoon. Tributaries of East Bay River originate in the upland area north of the tombolo-like section of the peninsula and the river currently occupies an extended drainage course westward along the axis of the former lagoon. The surface of this area slopes slightly toward the river and has an average elevation of 7 1/2 meters.

Terraced Upland. This is the largest physiographic division, comprising roughly two-thirds of the Ranger area (Figure 7). Fringed by sedimentary accretions at the base of terrace scarps, this area exposes at least two ancient marine terraces of Early Wisconsin and Illinoisan age, with the

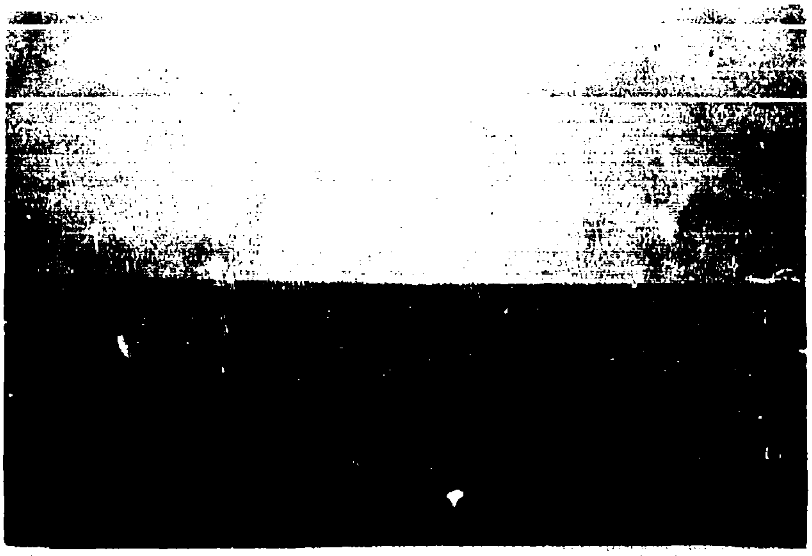


Figure 7. Terraced Upland view from Metts Tower toward Yellow River.

Figure 8. View at the head of Indigo Creek steephead.

oldest occupying the greater portion of the plateau-like surface at an average elevation of 38 meters above sea level. The terrace margins and surfaces are deeply incised, particularly along the southwest-northeast trending boundary of this area, by dendritic-patterned gulleys and box canyons, locally known as steepheads (Figure 7). One of these, occupied by Boiling and Holley Creeks, nearly severs this subdivision into two sections by extending southeast, then northeast across the uplands for a total distance of 10 1/2 km. Several of these remarkable erosional features have cut back into the highest portion of the highest upland lying along the north central margin of the area. Here, the maximum elevation, 64 meters, occurs on small, remnant knobs above a general surface of 49-55 meters. This highest upland altogether comprises less than 7% of the total Ranger area. The coarser deposits underlying the surface in this section may represent an extension of the Citronelle deltaic plain of Pliocene-Pleistocene age exposed [illegible] coastal lowlands throughout the eastern [illegible] Cooke, 1945; [illegible]ose, et al., 1946).

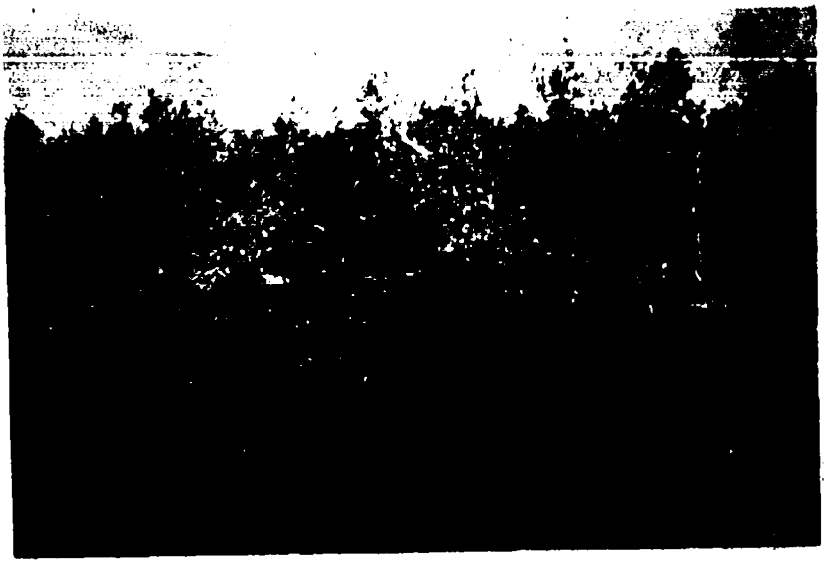
__Yellow River Alluvial Plain__. This subdiv[illegible], delimiting the Ranger training area on the north-northwest, has an

average elevation of 3-6 meters. The Yellow River flows southwestward over an apparently extended course characterized by bordering swampland, floodplains, natural levees, and an extremely braided channel development over the last 24 km. of its course (Figure 9). Many of the surface features in this subdivision bear resemblance to the East Bay Swamp Area, a major difference being the sharper escarpment forming the boundary of the alluvial plain and breached by tributary streams flowing from the steepheads. In the northeastern section of this subdivision, it is entirely possible that the Yellow River has cut into Alum Bluff (Miocene) clay equivalents. To the southwest, the plain is composed of alluvial and estuarine detritus from several sources.

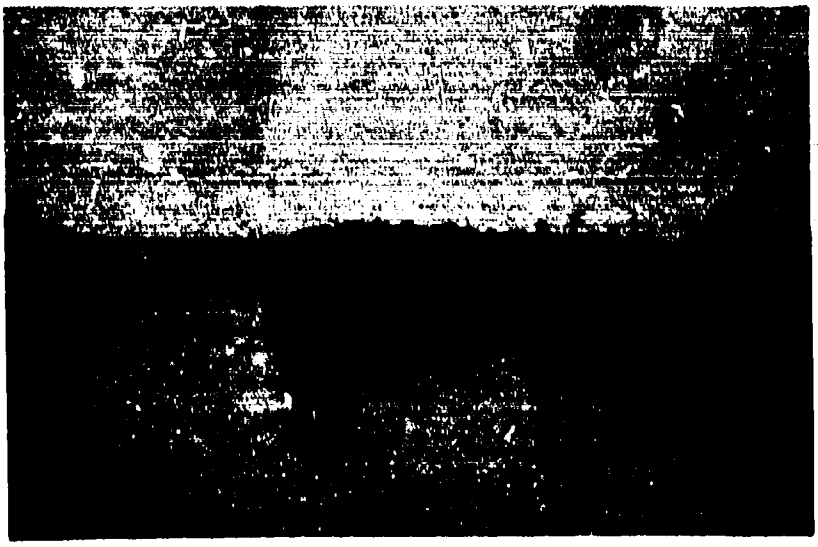
B. Geology and Pedology

1. General Geology

General or limited references to the geology of the Eglin Field area can be found in Matson and Sanford (1913), Cooke and Mossom (1929), Cooke (1939, 1945), Vernon, Puri, and Calver (1956), and Puri and Vernon (1959). No detailed geologic studies of Escambia, Santa Rosa, and Okaloosa counties have been published to date. Recently, Musgrove, Barraclough, and Marsh (1961) have supplied more specific information on



A



B

Figure 9. Views of the Yellow River. A. Near Highway 96 Bridge. B. Branching around an alluvial island northeast of A.

part of the area with reference to groundwater occurrences. Published geologic maps (Stose, et al., 1932; Cooke, 1945; Stose, et al., 1946; and Raisz, et al, 1964) are of limited usefulness due to insufficient scale, generalized boundaries or questionable accuracy.

The regional geologic setting for the western Gulf region as described by Murray (1961) will suffice as background for a more detailed account of the surface materials present in the Eglin area that follows.

The Eglin area is mainly situated on four or five, broad, coastwise, marine terraces exposed above sea level as a result of eustatic or epeirogenic changes during or since the Pleistocene. Seaward, successively younger terraces are composed of fine to medium-grained argillaceous, rudaceous, and arenaceous sediments, occurring separately or mixed in various proportions. These formations, gently dipping seaward between 18-20 feet per mile, are predominately composed of unsorted, uncemented, quartz sands, commonly set in a silty or organic matrix with occasional seams of clay (Vernon, Puri, and Calver, 1956). Along the coast and for several miles inland, the younger terraces are broad, coastal flats with swamps and marsh developed in depressions and on the margins. Bays and lagoons with offshore bars or islands commonly border the lowest (and youngest) terrace.

Landward, successively older terraces have greater height, gulfward slope, and higher elevation. They have been extensively eroded and

weathered. Similarly, inner terrace surfaces and deposits show more pronounced exposure effects than do equivalent coastwise surfaces. Penecontemporaneous fluviatile sediments extend variable distances up the major rivers such as the Yellow River, and such older deposits are obscured by more recent deltaic and floodplain alluvial accretions with which they have been intertongued and intermixed.

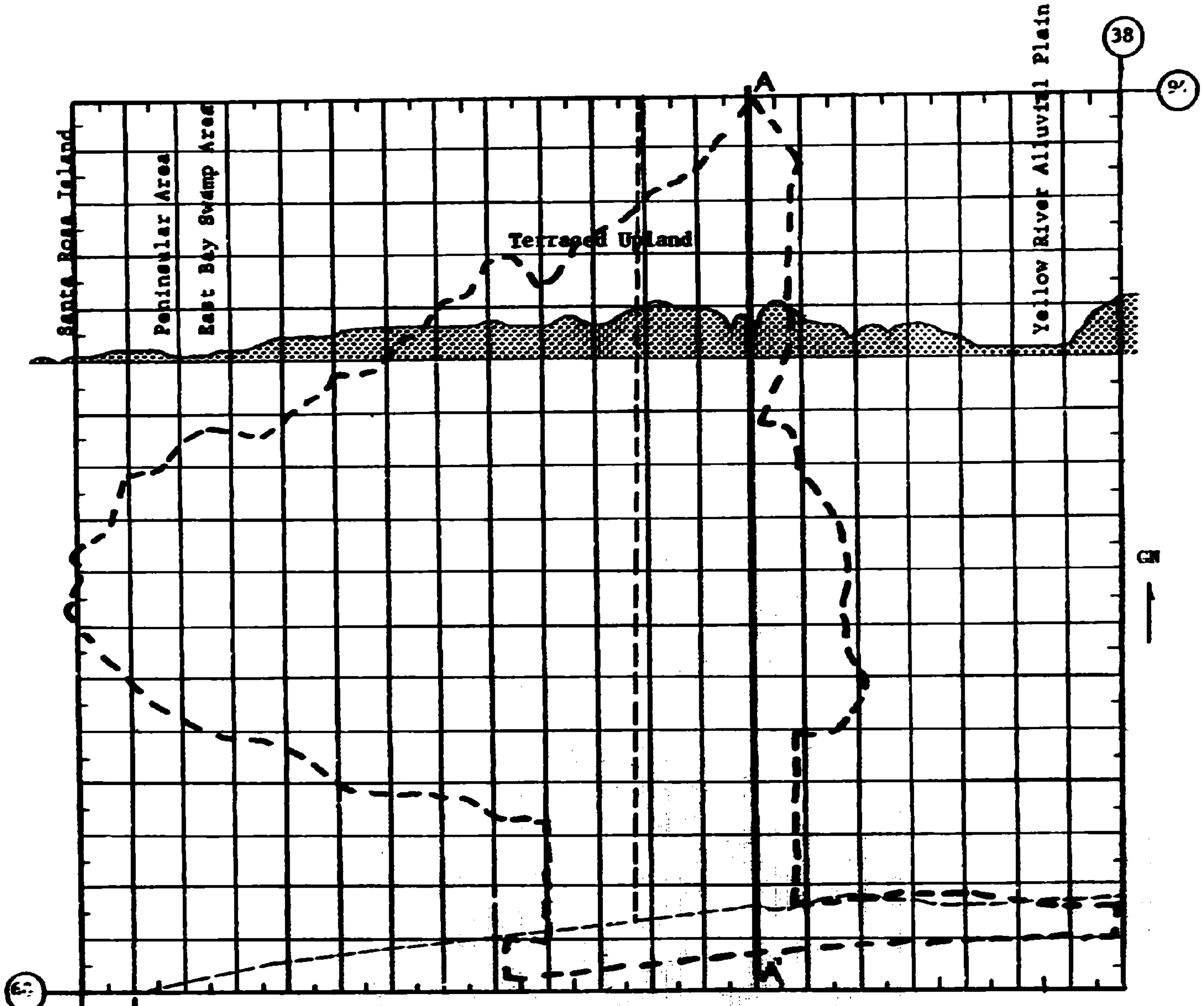
In a humid, subtropical region averaging 60-80 inches of rainfall annually, older deposits are deeply weathered and leached, low in organic content on the whole, light-textured and sandy, with red, yellow, gray, and other light colors predominating. The younger deposits, being lower, reflect relative proximity to the water table.

Generally low, distinct to indistinct, erosional escarpments or changes in seaward slope, separate the various terrace surfaces which are characteristically flat or gently undulating. Nips or toes of such escarpments have been used along North American coasts to depict approximate ancient shore lines (Cooke, 1945; MacNeil, 1950: Doering, 1956; and others). In the Eglin Field area, apparently significant changes in elevation and character of surfaces are believed to exist at or near the 10-, 20-, 40-, 70-, and 100-foot contour lines, these serving to separate as well the physiographic subdivisions described in the preceding section. There seems to be little doubt of the presence of the Pamlico, Wicomico, Okefenokee, and possibly the Coharie formations and terraces as described

by Cooke (1945), Vernon, Puri, and Calver (1956) and others in the area (Figure 10).

In the northeastern part of the Ranger area, mainly in Okaloosa County, older and coarser, terrace-like deposits of possibly subaerial, deltaic origin are present. These deposits resemble those assigned in other areas to the Citronelle formation, regarded by Cooke (1945) as Pliocene in age and by others (Murray, 1961; Vernon, 1942, 1951) as Early Pleistocene. Older deposits than these are not exposed on the surface in the Eglin Field area although beds of Miocene age may be close to the surface if not cut into by the Yellow River and some of the steepheads in the northeastern section.

Thick sections of terrace deposits are exposed in the steepheads in the northern half of the Upland Area. In this subdivision, remnants of the Coharie terrace or Citronelle formation lie above 200 feet, and remnants of the Okefenokee terrace are on the surface between 150-200 feet in elevation. The main surface blanket of the upland section is composed of Wicomico terrace materials which are exposed over a large area between 100-150 feet in elevation, extending from south of the Yellow River to the northern margin of the East Bay Swamp Area. In the steepheads they cap as much as 14.6 meters of thick sand beds, composed largely of medium-sized quartz grains, in places cross-bedded, with occasional .6-.9 meter thick, red, yellow, orange, or variegated, sandy



——County Lines

Scale 1:200,000 Approx.

Figure 18. South to north terrain profile of the Eglin Field area. Profile drawn along line A-A' on the base map. Vertical exaggeration 42X.

and blocky, clay beds forming perpendicular sidings in the gulley walls. An excellent exposure of this material, representing Okefenokee, Coharie, and possible Citronelle formations, can be seen a short distance north of the Ranger base camp in the Holley Creek steephead.

The prominent escarpment bordering the Upland Area represents a drop to the Pamlico terrace, the toe of which lies near the 30-foot contour line. The East Bay Swamp Area and the Peninsular Area are associated with this terrace as are estuarine and fluviatile equivalents in the Yellow River Alluvial Plain section. The Pamlico terrace is characterized by current swamplands and poorly-drained, muck-filled depressions lying on the low-lying terrace surface. Following the interpretation of the Peninsular Area advanced earlier, to which the views of Cooke (1945) and MacNeil (1950) give some support, the area extends along the longitudinal axis of a Pamlico bar developed parallel to the coast and flanked by a nearly filled Pamlico lagoon (East Bay Swamp). Elliptical to subrounded mounds, better than 10 feet high, occur in the Peninsular Area and probably represent "fossil" dunes.

Along East Bay River southwest of Holley, an escarpment less than 10 feet in elevation above sea level may indicate the post-Wisconsin (Silver Bluff) rise in sea level noted by some authors (Vernon, Puri, and Calver, 1956; MacNeil, 1950).

2. Lithology and Pedology

a. General observations. The general lithologic character of this section of the coastal plain is revealed in a log from a well drilled at Cantonment, Escambia County, a few kilometers west of the Eglin area, as reported by Matson and Sanford (1913). The upper 91.4 meters consists of relatively thin beds (.9-4.6 meters thick) of sand and fine gravel alternating with thick (4.6-24.4 meters) beds of clay and silty clay.

On the surface, the sands which predominate have been variously described as snow white to drab gray to light tan, brown and red sands ranging in texture from very fine to very coarse but fine to medium-grained on the average. The sands are well to poorly sorted but are usually moderately well sorted. Admixtures of clay and silt, up to 35-40% of a given sample, result in a loamy texture commonly found on the higher terraces.

The predominant mineral component of the sands is quartz, reaching nearly 100% in most samples inspected from Santa Rosa Island. Variations are provided by finely disseminated organic material, and carbonaceous, limonitic, and hematitic stains. The quartz grains range from fairly well rounded to subangular. The general absence of carbonates and, except for restricted occurrences, organic matter are especially noteworthy. The highly siliceous nature of the surface materials

at Eglin Field contributes importantly to the acidic quality of the whole terrain. (Figure 11).

Coarser sediments ranging from granules to pebbles, typically pea-sized or slightly larger, infrequently occur as thin zones in the sands, and stringers and lenses of gravel can be seen grading into sand locally. The coarser materials are composed of dense quartz and chert with occasional kaolinitic pebbles. The great majority of these coarser materials are clastic but occasional concretionary structures are seen.

Although thick to thin clay seams and lenses are common in the stratigraphic section through the coastal terraces, surface exposures of clay in the Eglin area are rare by comparison with sediments of larger size. Patches of sticky to plastic, gray to yellow and red clay are exposed on some of the steeper slopes in the more dissected north central upland section where sandy surface soil has been removed. Clay-sized alluvium forms a thin veneer on parts of the Yellow River flood plain. Vertical exposures of clay can be seen in the steep heads and higher roadcuts in the upland section. A largely fine to medium-grained sand with 4% or more finely disseminated, red, plastic clay is utilized in the area for road surfacing and subgrade treatment. It is quarried in the Eglin area near the upper edge of the upland escarpment north of Bear Creek (16.2 x 85.2; 14.4 x 83.9).

A

B

Figure 11. Eglin Field area sand. A. Wave-cut beach, Santa Rosa Island. B. Typical surface along East Bay Swamp road.

Cumulose deposits of peat and muck in significant proportions occur at or near the surface in poorly drained depressions in the East Bay Swamp Area. These deposits, formed during evolutionary stages in the sedimentary filling of the area, are commonly mixed with sandy and silty clastic material. Thin blankets of sand often overlie older muck in the higher portions of the swamp area.

Dense hardpan layers of limited lateral extent, formed by the cementing of sand by iron oxides precipitated from ground water, occasionally crop out on the surface in cuts. These layers, sometimes stained with organic matter, typically measure a few centimeters in thickness but some layers up to 1.2 meters thick have been reported (Musgrove, Barraclough, and Marsh, 1961). Representing the only consolidated rock to effect the surface in the entire area, hardpans do not constitute a significant fraction of the surface materials in the Eglin area. However, the apparent influence of these layers, along with similarly impermeable and discontinuous layers and lenses of clay, in controlling drainage and ground water movement is of considerable importance in the development of surface features.

b. Soils. Despite the homogeneity of surface materials over large sections of the Eglin area, a variety of soil types has developed from a relatively few kinds of unconsolidated parent material within a comparatively short segment of geologic time. Differences in physio-

graphic position and in the nature and extent of subsurface drainage appear to have exercised major control over soil development in the area.

Until recently, reports on the soils of western Florida have been limited to cursory or generalized accounts by Sellards (1912) and Henderson (1939). No detailed investigations of soils have been made in Santa Rosa and Okaloosa Counties, embracing the greater part of the Ranger area. A detailed soil survey of Escambia County by Walker, Carlisle, and Hasty (1960) provides a useful reference for the general area. The belted nature and geological contemporaneity of coastal plain materials, and the consequent repetition of environmental situations make it possible to recognize soil type analogs in the Eglin area, confirmed through field reconnaissance and observations made at the vegetation sampling sites.

All stages of soil genesis occur in the Eglin area. Zonal soils referable to the Red-Yellow Podzolic group; intrazonal soils including representatives of the Planosol, Low-Humic Gley, Humic Gley, and Ground-Water Podzol groups; and the azonal Lithosol (Regosol) group are combined in a number of soil associations in the area. Soils assignable to the Carnegie, Faceville, Izagora, Kalmia, Norfolk, Ruston, Tifton, Savannah, Plummer, Pamlico, Rutledge, Leon, Cuthbert, Eustis, Huckabee, Klej, Lakeland, Lakewood, Myatt, and Sunsweet series can be differenti-

ated in the Eglin area. In addition, undifferentiated soil groups, complexes, and miscellaneous land types occur on Santa Rosa Island (dune and beach land and tidal marsh), along the Yellow River (mixed alluvium and fresh water swamp), and on the upland escarpment. Many phase variations of most of these soils undoubtedly exist in the area.

No attempt is made in this report to present a detailed soil survey of the Ranger area. However, on the basis of reconnaissance and site data and by using correlations with apparent soil analogs in Escambia County and elsewhere (Henderson, 1939; Walker, Carlisle, and Hasty, 1960), sixteen soil types have been established which are believed to cover the range of soils in the area fairly well. In the descriptions of soil types which follow, textural, structural, and most other soil terms largely follow the definitions employed by the Soil Conservation Service (U.S.D.A., 1951). American Association of State Highway Officials and Corps of Engineers (Unified) classification references included in the descriptions are based on Escambia County soil analogs (Walker, Carlisle, and Hasty, 1960) but they appear to be reasonably applicable to Eglin Field material.

<u>Soil Type 1</u>.
Origin: Recent wave and wind.
Location: Offshore bar: Santa Rosa Island.
Topography: Gently sloping, bordering beach, ridges, and dunes to 9 meters or more in height, intradunal swales less than 3 meters above sea level.
Depth to water table: Beach and swale, .6 meter or less; dunes, .6 meter or more.

Profile: Surface: Deep, white, fine- to medium-grained, quartz sand, single grain structure, generally well-sorted.

Subsoil: No differentiation.

Drainage: Excessively drained excepting some swale depressions where water is temporarily ponded; and along intertidal beach zone.

Permeability: High.

Water holding capacity: Generally poor.

Classification Reference: Unified: SP.

A.A.S.H.O.: A-3.

U.S.D.A.: Coastal Dune Land and Beach.

Soil Type 2.

Origin: Recent estuarine sand, silt, clay, and accumulated herbaceous plant remains.

Location: Typically along margins of overwash promonotories on landward side of Santa Rosa Island. Small patches fringe tidal channels bordering on East and Blackwater Bays.

Topography: Tidal flats slightly above sea level.

Depth to water table: .6 meter or less.

Profile: Mixtures of organic material and sediment, clay lenses, largely undifferentiated.

Drainage: Very poor, tide water drainage; mostly covered at high tide.

Classification Reference: U.S.D.A.: Tidal Marsh.

Soil Type 3.

Origin: Materials forming the offshore bar predecessor of Santa Rosa Island and subsequent additions.

Location: Peninsular Area bounded by Santa Rosa Sound and East Bay Swamp.

Topography: Level to nearly level surface (less than 5% slope) with fossil ridges, dunes, and swale depressions preserved in places. Most of area covered lies between 6 and 9 meters elevation.

Depth to water table: Mostly 3 meters or more; less near the Sound.

Profile: Surface: Light gray, structureless sand, a few cm. deep; addition of small amount of disseminated organic matter gives soil a salt and pepper appearance.

Subsoil: White to brownish yellow, loose sand; a white sand layer at the top of this zone is distinctive in places.

Drainage: Excessive to somewhat excessive; slow runoff, internal drainage rapid.

Permeability: High.

Water holding capacity: Low.

Classification Reference: Unified: SP.
A.A.S.H.O.: A-3.
U.S.D.A.: Lakewood-Lakeland.

Soil Type 4.

Origin: Old coastal materials as in Type 3; some secondarily transported.

Location: Low ridges within wet sections of Peninsular and East Bay Swamp Areas. Closely associated with Type 7.

Topography: Level to nearly level low relief between 3 and 9 meters elevation; usually lower than Type 3, higher than Ty- 4.

Depth to water table: Less than .6 meter.

Profile: Surface: Dark gray to white, loose sand less than .3 meter in depth.

Subsoil: Sand of variable colors from white to dark brown to yellow and reddish yellow, mottled. This soil features an organic-stained, cemented hardpan below .3 meter.

Drainage: Poor; becomes saturated during rains.

Permeability: High in surface portion above hardpan.

Water holding capacity: Low.

Classification Reference: Unified: SP.
A.A.S.H.O.: A-3.
U.S.D.A.: Leon.

Soil Type 5.

Origin: Same as Types 3 and 4.

Location: Low places above 3 meters elevation in Peninsular and East Bay Swamp Areas, mainly in the latter adjacent to streams. Associated with Type 8 in East Bay Swamp Area and Type 14 along the Yellow River.

Topography: Level to gently sloping toward drainageways.

Depth to water table: Less than .3 meter.

Profile: Surface: Gray to dark gray, fine to medium sand

and loamy sand, 20 1/2 cm. or less, loose to very friable.

Subsoil: Light gray to grayish brown with dark brown loamy mottles. Loose to very friable.

Drainage: Poor; seepage water stands on much of the surface following rains.

Permeability: High.

Water holding capacity: Somewhat low.

Classification Reference: Unified: SM-SP.
A.A.S.H.O.: A-2 to A-3.
U.S.D.A.: Plummer.

Soil Type 6.

Origin: Some from sources similar to Types 3, 4, and 5; some developed on or derived from Pleistocene terrace material.

Location: The least restricted and most widely distributed soil type in the Eglin area. Occurs on broad to narrow ridges and slopes along the outer margin of East Bay Swamp, over a large portion of the Upland Area between 30 and 46 meters elevation, especially south of the Boiling Creek-Holley Creek barranca and on inter-steephead divides southeast of the Yellow River floodplain; and along the outer escarpment margin of the Yellow River Floodplain Area.

Topography: Level to sloping (ca. 10%).

Depth to water table: 3 meters or more.

Profile: Surface: Oxidized and leached, dark to grayish and yellowish brown, fine sand to loamy sand, loose to friable, .15 to .3 meter in depth.

Subsoil: Yellow and yellowish brown to brownish or reddish yellow sand to loamy sand, loose to friable. May have sandy clay layer below .6 meter depth.

Drainage: Slow to rapid runoff; usually infiltration and internal drainage rapid. Altogether somewhat excessively drained.

Permeability: High.

Water holding capacity: Low.

Classification Reference: Unified: SM or SP in upper part; ML or SC in lower part.
A.A.S.H.O.: A-2 to A-3 in upper part; A-4-A-6 below.
U.S.D.A.: Lakeland-Eustis.

<u>Soil Type 7</u>.

Origin: Source areas supplying sedimentary fill.

Location: Low ridges within broad, wet areas in East Bay Swamp. Closely associated with Type 4.

Topography: Level to gently sloping.

Depth to water table: .6 meter or less.

Profile: Surface: Dark gray to blackish sand or loamy sand, structureless to friable, less than .3 meter depth.

Subsoil: Brownish yellow to yellowish brown, sand to loamy sand with yellow, red, and brown mottles.

Drainage: Somewhat poor; subsoil nearly saturated during rains.

Permeability: Moderate; low intake rate.

Water holding capacity: Low.

Classification Reference: Unified: SM or SP at or near surface; SC or ML at depth.

A.A.S.H.O.: A-2 or A-3 above; A-4 at depth.

U.S.D.A.: Klej.

<u>Soil Type 8</u>.

Origin: Lagoon-filling materials from adjacent uplands.

Location: Broad, low, wet areas in depressions, or adjacent to fresh water swamp. Associated with Type 5 in East Bay Swamp Area.

Topography: Nearly level, slightly sloped toward center of depressions.

Depth to water table: .3 meter or less.

Profile: Surface: Friable to crumbly black sand to loamy sand, around 36 cm. in depth.

Subsoil: Crumbly to structureless, dark gray to brownish gray sand with much organic matter.

Drainage: Slow external and internal drainage; ponded after prolonged rains.

Permeability: Moderate.

Water holding capacity: Average at surface, decreasing with depth.

Classification Reference: Unified: SM at surface, SP below .3 meter.

A.A.S.H.O.: A-2 at surface, A-3 below.

U.S.D.A.: Rutledge.

Soil Type 9.

Origin: Accumulated plant remains mixed with alluvium.

Location: Depressions in East Bay Swamp Area.

Topography: Level or nearly so.

Depth to water table: At or near zero.

Profile: 1.8 meters or less, structureless, black muck composed of fairly well decomposed plant materials overlying sticky, black, mucky sand.

Drainage: Very poor. Water moves laterally to small streams which flood easily during prolonged rains. As seepage catch basins, these tracts are ponded most of the time.

Permeability: Variable; compaction of material increases with depth.

Water holding capacity: High.

Classification Reference: Unified: Upper portion: Pt; SM or OL below.
A.A.S.H.O.: A-5 over A-2.
U.S.D.A.: Pamlico Muck.

Soil Type 10.

Origin: Thick beds of unconsolidated, noncalcareous, marine Pleistocene sediments.

Location: The surface soil over much of the Upland Area between 30 and 46 meters elevation not occupied by Soil Type 6.

Topography: Nearly level to gently sloping, except for occasional broad, shallow depressions and smaller low rises of subcircular outline.

Depth to water table: Considerably greater than 3 meters.

Profile: Surface: Friable, grayish to yellowish brown, fine sandy loam, .3 to .6 meter in depth.
Subsoil: Mostly brownish yellow, mottled with reddish yellow, fine, sandy, clay loam, firm to subangular blocky consistency. A clay hardpan develops occasionally within the upper 1.2 meters.

Drainage: Medium to rapid surface drainage; medium to slow internal drainage, especially where claypan is present.

Permeability: Surface soil is highly permeable; subsoil moderately or slowly permeable. Precipitation is absorbed quickly without runoff, moves laterally in subsoil.

Water holding capacity: Moderate to high.
Classification Reference: Unified: Upper .3-.6 meter- SM or SC; Below: SM, CM, or ML.
A.A.S.H.O.: A-2 to A-4 above; A-2 to A-7 below.
U.S.D.A.: Norfolk, Ruston, Savannah, separate or undifferentiated.

Soil Type 11.

Origin: Same as Type 10.
Location: Typically on higher and more dissected terrace between 46 and 61 meters, lying north and northeast of Holley Creek (Coordinates: 78-86 x 16-25).
Topography: Broad, smooth, plateau-like areas and adjoining general slopes (less than 10%).
Depth to water table: Considerably greater than 3 meters.
Profile: Surface: .3 to .6 meter dark gray or brown to brownish yellow or gray, fine sandy loam, granular to crumb structure. Numerous iron concretions are characteristically distributed from the surface to some in the redder phases of this soil type.
Subsoil: Brownish yellow to yellowish red, in mottles or uniformly throughout, fine sandy clay loam to sandy clay. Friable to subangular blocky. Quite variable.
Drainage: Medium to rapid surface drainage (vertical); medium to slow natural drainage.
Permeability: Moderate to low, decreasing downward.
Water holding capacity: High.
Classification Reference: Unified: Surface: CL, SC, or SM. Subsoil: SC, ML, CH, or CL.
A.A.S.H.O.: A-2 or A-4
U.S.D.A.: Tifton, Carnegie, Faceville, separately or undifferentiated.

Soil Type 12.

Origin: Same as Types 10 and 11.
Location: Typically exposed at abrupt changes in slope, especially in the steepheads and along the northern upland escarpment in the Eglin area.

Topography: Strongly sloping to steep.
Depth to water table: Considerably greater than 3 meters. Perched aquifers formed by clay and concretionary layers are intersected on the steeper slopes, releasing springs along the walls of the steep heads and elsewhere.
Profile: Surface: Dark, grayish brown to yellowish brown, friable, loamy sand or fine sandy loam approximately .46 meter in depth.
Subsoil: Brownish yellow to reddish yellow, or yellowish red, friable to very friable, fine sandy, clay loam or fine sandy clay with brown, gray, or red mottles or zones. Occasional concretionary structures.
Drainage: External drainage medium to rapid, somewhat excessive; internal drainage slow to rapid, depending on presence of sandy clay substrata.
Permeability: Moderate to low.
Water holding capacity: Low to very low.
Classification Reference: Unified: Surface: SM, SC, or SP.
Subsoil: SC, ML, CH, CL, or MH.
A.A.S.H.O.: Surface: A-2 to A-4; Subsoil: A-2 to A-6 or A-7.
U.S.D.A.: Undifferentiated Lakeland, Ruston, Norfolk, Sunsweat, Carnegie, Cuthbert.

Soil Type 13.
Origin: Colluvial material from uplands, and older coastal plain alluvium lying above present stream surface.
Location: Rarely overflowed second bottom river terraces, benches, and natural levees along the higher, outer portion of the Yellow River alluvial plain.
Topography: Level to very gently sloping.
Depth to water table: .6 to 1.6 meters.
Profile: Surface: Crumb-structured, dark grayish brown, fine sandy loam or loamy fine sand to a depth of 1.8 meters, usually around .6 meter.
Subsoil: Yellowish brown to brownish yellow, crumb to subangular blocky, deep sand or sandy clay loam to sandy clay.

Drainage: Good to moderately well-drained; rapid internal drainage in sandier phases, decreasing with depth and increase in subsoil silt and clay.

Permeability: High to low, decreasing with depth.

Water holding capacity: Low to high, increasing with depth.

Classification Reference: Unified: Surface: SM, SC, or ML.
Subsoil: SC, ML, or CH to CL.
A.A.S.H.O.: A-2 or A-4 above; A-4 to A-6 or A-7 below.
U.S.D.A.: Huckabee-Kalmia-Izagora undifferentiated.

Soil Type 14.

Origin: Mixture of dissimilar colluvial and alluvial materials.

Location: Shallow depressions and first bottom areas slightly above stream level in the Yellow River Alluvial Plain Area where it intergrades with Soil Type 5.

Topography: Flat to nearly level.

Depth to water table: A few centimeters to .6 meter.

Profile: Not well defined; not a product of soil development but accumulation, subject to periodic additions and removal. Gray to black, fine sand to sandy loam and sandy clay loam below .6 meter.

Drainage: Frequently flooded; surface runoff slow. Generally poorly drained, especially above .6 meter depth, depending on height above water table.

Permeability: Low.

Water holding capacity: High.

Classification reference: Unified: SC, SM to CL.
A.A.S.H.O.: A-2, A-4, or A-6.
U.S.D.A.: Mixed Alluvial Land.

Soil Type 15.

Origin: Intricate mixture of soils and sediments washed from uplands along with organic material accumulation *in situ*.

Location: Bordering the Yellow River in long strips.

Topography: Zero to one per cent slope.

Depth to water table: Zero most of the time.

Profile: Not developed. Color (dark), texture, compo-

sition, and thickness highly variable. Composed of stratified sand, clay, and organic matter (sometimes below mineral soil). In places this soil resembles Soil Types 8 and 9 of the East Bay Swamp Area. The texture of organic accumulations is gross with large fragments in contrast to muck.

Drainage: Very poor. All or most covered or saturated throughout the year. Subject to overflow.

Permeability: Low.

Water holding capacity: High.

Classification Reference: Unified: SM or SP to CH.
A.A.S.H.O.: A-2 to A-7.
U.S.D.A.: Fresh Water Swamp.

<u>Soil Type 16</u>.

Origin: Recent alluvium, at least superficially.

Location: Irregular patches along the Yellow River and larger creeks, and in low places near streams or slightly depressed areas at foot of higher terraces.

Topography: Level to nearly level.

Depth to water table: .3 meter or less.

Profile: Surface: Dark gray to light gray, stratified, loamy fine sand with crumb structure to a depth of .3 meter or slightly more.
Subsoil: Gray with yellow and gray mottles, fine sandy clay loam with blocky subangular structure; semiplastic.

Drainage: Poor. Surface and internal drainage slow; frequently flooded; water stands following rains.

Permeability: Very slowly permeable.

Water holding capacity: Moderately low.

Classification Reference: Unified: Surface: SM or ML.
Subsoil: SC to CL.
A.A.S.H.O.: A-4 at or near surface, A-6 below.
U.S.D.A.: Myatt.

Point occurrences of specific examples of several of the soil types described in the foregoing account are shown on Figures 12 through 14 which represent three south to north sections of a strip map bounded by vertical co-ordinates 17 and 24 and horizontal co-ordinates 60 and 96.

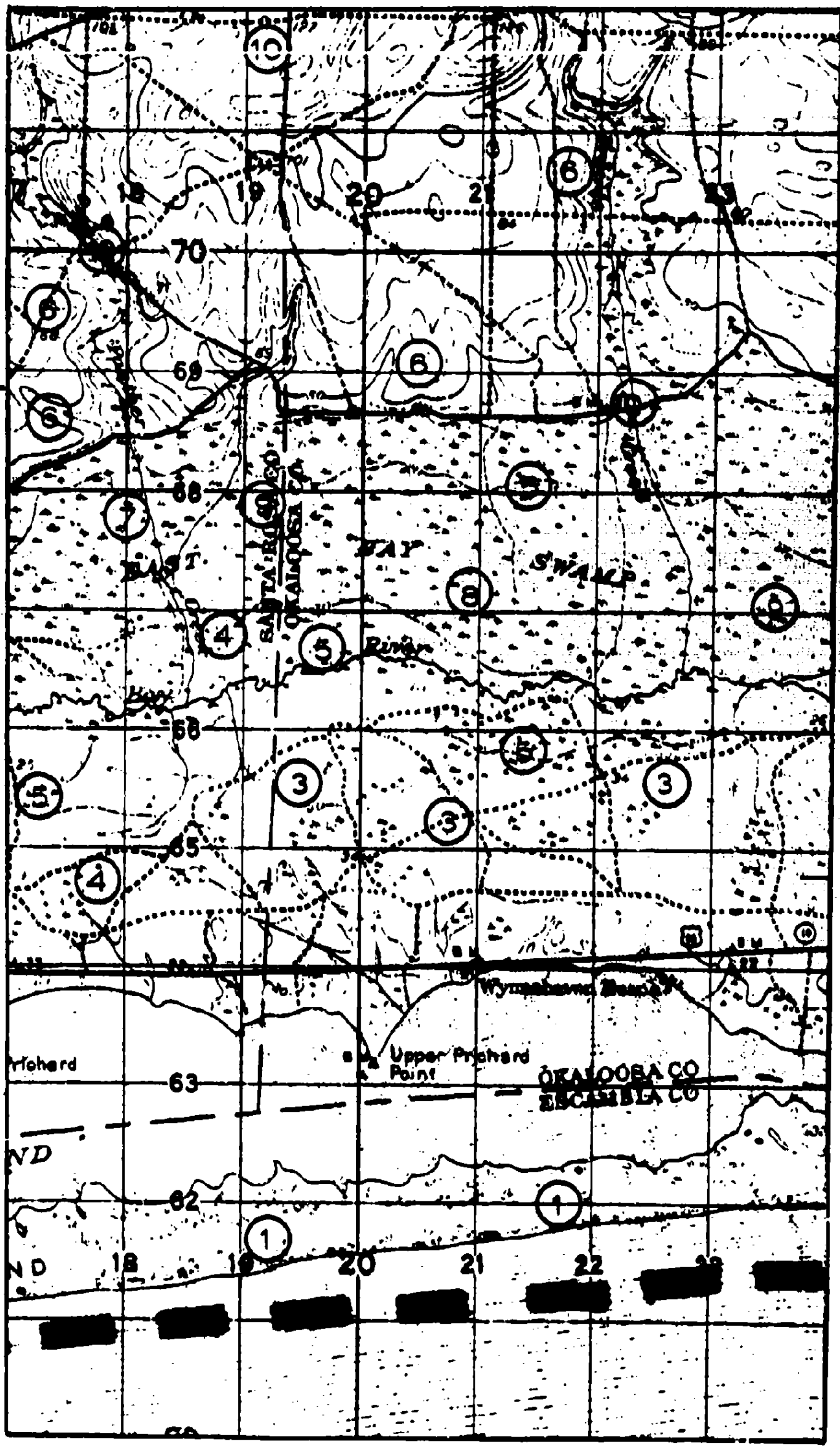
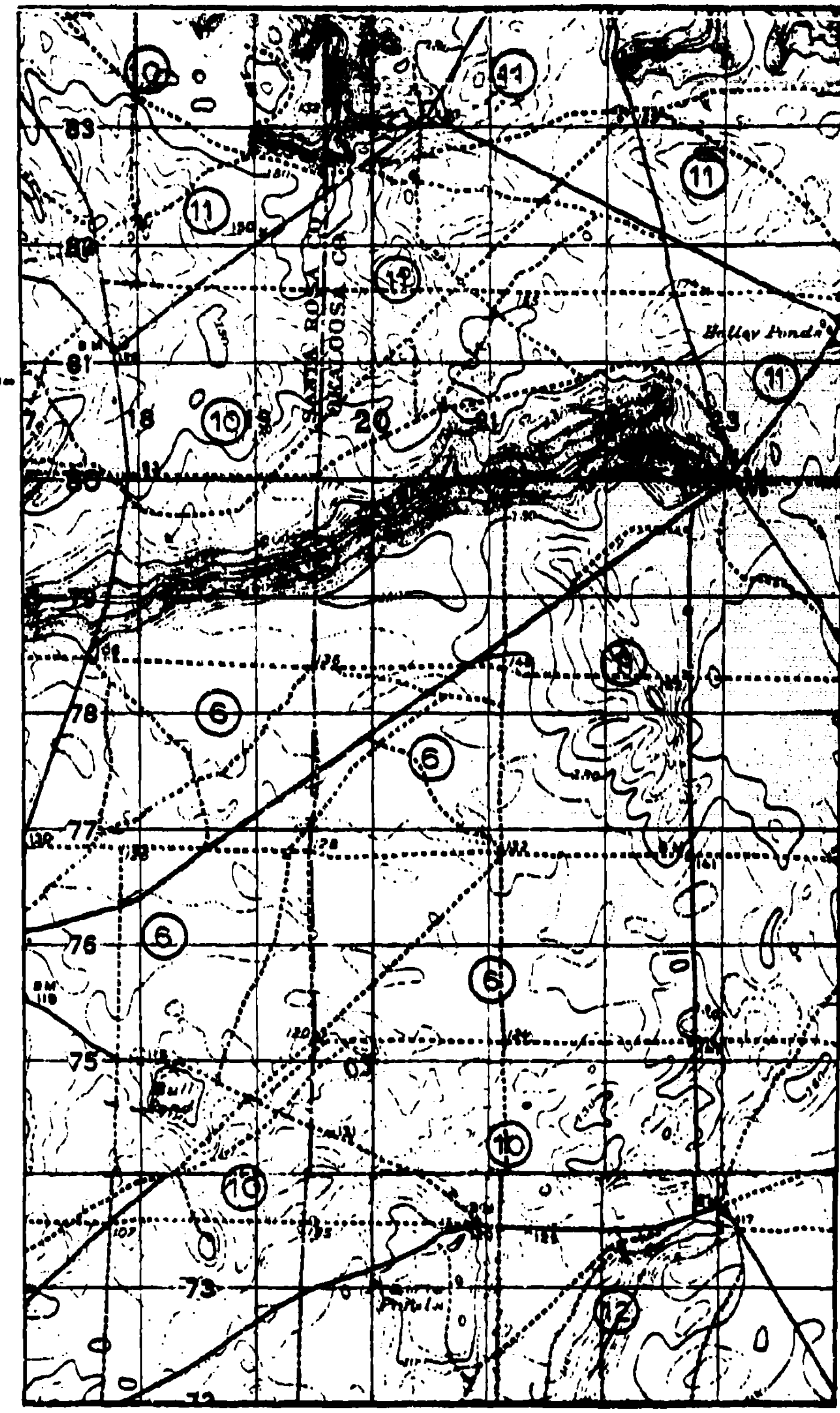


Figure 12. Representative soil type distribution in the Santa Rosa Island, Peninsular, and East Bay Swamp Areas, and along the southern margin of the Upland section.

Figure 13. Representative soil type distribution in the Terraced Upland section.



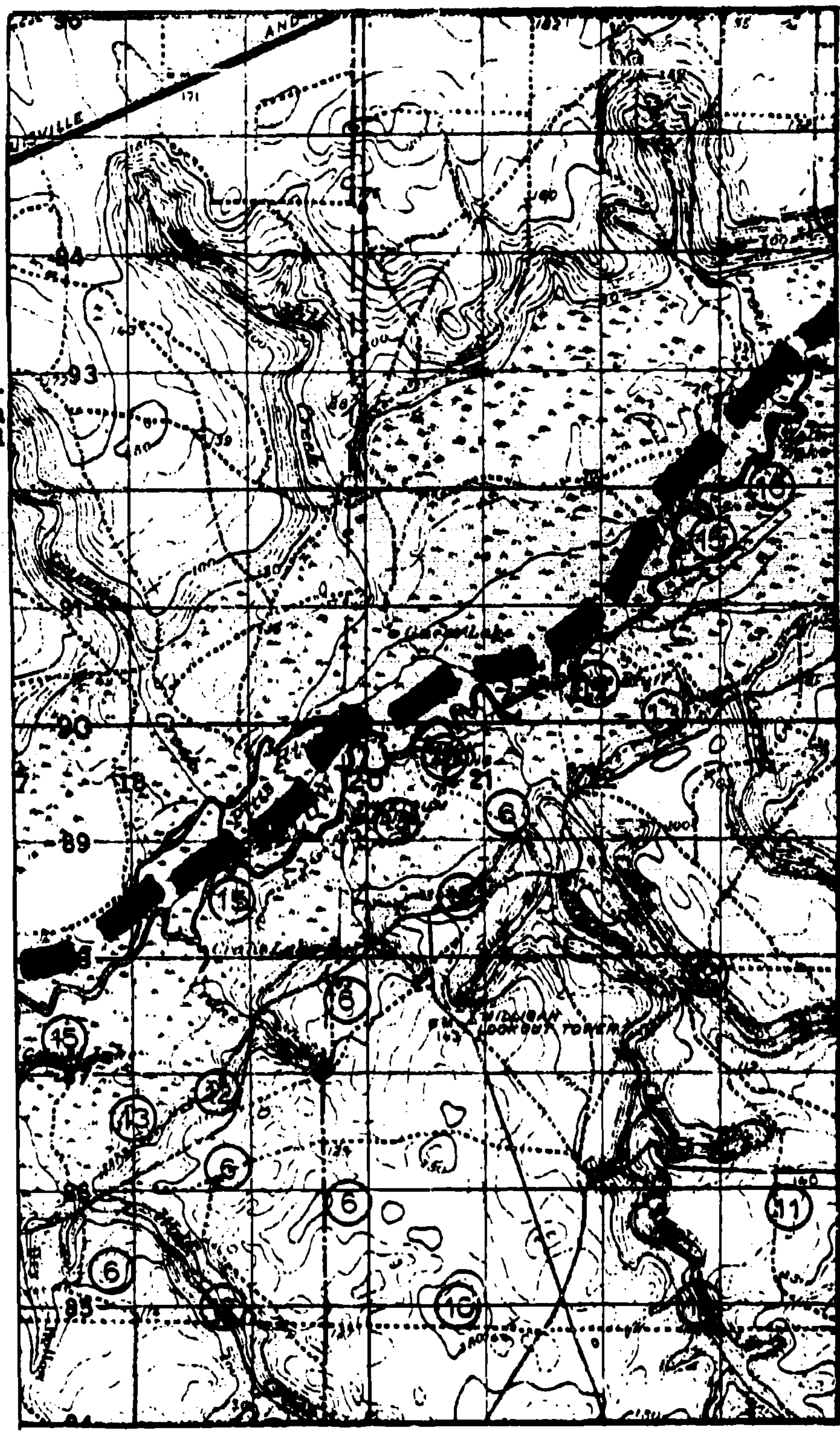


Figure 14. Representative soil type distribution along the northern escarpment of the Upland section and on the Yellow River Alluvial Plain.

This particular traverse was selected primarily because it includes sections from all of the physiographic subdivisions and thus represents the range of relief, topographic position, hydrologic conditions, and other ecologic factors in the Eglin area. Secondly, a large number of vegetation sampling sites (Plate 8) were located with the traverse boundaries, providing additional control points at which soil observations could be recorded.

Many of the soil types described in this survey are comparable to series of group rank in the hierarchy of soil classification. Others are more specific entities with little or none of the variation that might be expected to occur from site to site in areas underlain by the more generalized types. Even among the latter, however, the degree of confidence with which projections of type occurrence boundaries beyond the plotted points or extrapolations between them can be made is fairly high within a given physiographic subdivision. It seems reasonable to assume that the degree of confidence might be expected to decrease progressively with increase in percentage and variation of slope, with an increase in the degree of local fluctuation in the position of the water table, and with an increase in proximity to a given physiographic interface. Since major slope changes are relatively uncommon and restricted (escarpment, steepheads, and dissected upland), owing to the generally flat or slightly undulating topography over much of the surface,

fewer phase variations than usual on this account may be anticipated in the Eglin area. Rather more important is the areal continuity of the products of gleization and the factors responsible for it.

c. Litter and humus. As a part of the survey of surface materials at Eglin Field, litter observations were made and humus measurements were taken at 33 of the vegetation sampling sites. At none of these sites was there an accumulation of litter of sufficient component size as to be of microgeometric significance. Rather, the general absence of such materials is a noteworthy feature of the Eglin area terrain.

At most sites, humus layers could be differentiated into L (Aoo), F (Ao1), and H (Ao2) components as defined by Hoover and Hunt (1952). The sites and variations in humus development along with average measurements recorded in the study are grouped according to physiographic association as follows:

I. Terraced Upland.
    A. Main upland surface (16 vegetation sites-4 variations).
        1. Nearly pure pine stands, a few scattered hardwoods.
            L: 2.5 cm.
            F: 1.6 cm.
            H: 1.9 cm.
        2. Mixed pine and scrub oak.
            L: 1.3-2.5 cm.
            F: .95-2.5 cm.
            H: .64 cm.
        3. Scrub oak, scattered pine, grass, sometimes palmetto and low shrubs.
            L: 1.3 cm.
            F: .32-.64 cm.
            H: .32-.64 cm.

4. Scrub oak, bare sand.
    L: 1.3 cm.
    F: .32 cm.
    H: 0

Comments: The humus types at these representative sites range from mor developed on pine-dominated soils to mull humus characteristic of hardwoods, in the case cited, scrub oak. The L layer of the mor type is thicker and the transition from humus to mineral soil is abrupt with little incorporation of organic matter into the A horizon below. Where the mor type is developed, the rapid infiltration rate expected in the loose, sandy soils over most of the area is retarded. Complete mull development is not common although the H layer is relatively thin in all cases. Even scattered pines of mature size affect the development of the mull type. The rapid decomposition of deciduous hardwood debris and the downward transportation by water disperses the organic matter uniformly, resulting in a grayish cast to the soil in most cases, inhibits the concentration and precludes the formation of any but a thin H layer if at all. Exceptions occur where hardpans have developed, a feature of some soils in the Eglin area as noted in the preceding section.

B. Steepheads (5 vegetation sites - 4 variations).

1. Magnolia-dominated.
    L: 1.9-3.2 cm.
    F: .64-1.3 cm.
    H: 1.9-2.5 cm.
2. Deciduous hardwoods and magnolia.
    L: .32-.64 cm.
    F: .32 cm.
    H: .64 cm.
3. Live oak-dominated.
    L: 1.3-1.9 cm.
    F: .64 cm.
    H: 1.3 cm.
4. Titi with scattered pine and white cedar.
    L: .32-1.9 cm.
    F: .64-2.5 cm.
    H: 7.6-10.2 cm. over deep muck.

Comments: The sites are listed in order of their location

with respect to the long profile of the steephead. At or near the head (1,2) humus tends to accumulate in shallow troughs rather than have uniform and wide distribution. The evergreen leaves of magnolia and live oak account for thick humus development at sites (1,3) where these plants dominate and develop a mor humus type. The influence of increased numbers of deciduous hardwoods, by comparison, can be seen in variation 2. The site where variation 4 was observed is near the mouth of Boiling Creek steephead. The typical invasion of the steepheads by floodplain swamp vegetation, the rapid growth and decay of material from these plants, the extensive accumulation *in situ* of the remains, and the influence of poor drainage are all recorded in the humus development at the site.

C. Southern upland escarpment (6 vegetation sites-5 variations).

1. Scrub oak, scattered pine, 25% bare sand cover.
   - L: .64-5 cm.
   - F: .64 cm.
   - H: .64 cm.
2. Dense scrub oak.
   - L: .64-2.5 cm.
   - F: .64 cm.
   - H: .64 cm.
3. Pine and grass meadow.
   - L: 2.5-3.8 cm.
   - F: 2.5 cm.
   - H: .64-1.9 cm.
4. Live oak.
   - L: scant and scattered.
   - F: 0.
   - H: 0.
5. Scattered pine, scrub oak, palmetto, bare sand.
   Humus heaped under plants, especially palmetto; impossible to differentiate.

Comments: Most of these sites are near the base of the escarpment and could represent equally well many conditions along the inner and higher margin of the East Bay Swamp area. Example 1 illustrates the influence of large pines, although scattered, on the range of thickness of the L layer, the thinner extreme conversely recording the

uncontested dominance of scrub oaks. Example 2 mull and example 3 mor are well developed and could be predicted. Sites for examples 4 and 5 are located east of Escribano Point within sight of Blackwater Bay. The absence of litter and humus can be attributed to wind removal under essentially dune conditions. Many of the live oak leaves are trapped by the palmettos in the adjacent site used for example 5 and which has no live oak. The persistence of these evergreen leaves results in the prolonged accumulation of heaps of debris noted at the example 5 site.

II. East Bay Swamp Area..

A. Higher sites (3 vegetation sites-3 variations).

1. Live oak, scattered huckleberry.
   L: 1.3-2.5 cm.
   F: .32-1.3 cm.
   H: .32-1.3 cm.
2. Grass clumps with scattered pine and low shrubs.
   L, F, and H, intermixed.
3. Grass and weedy herb cover with 50% open area in bare soil. No measurable accumulation.

B. Wetter sites and depressions (4 vegetation sites-4 variations).

4. Sweet bay-tupelo.
   1 1/2 meters of muck recorded 30 1/2 meters from stream. In the stream, the sand bottom overlies older muck.
5. Titi-white cedar.
   L: 1.3-7.0 cm.
   F: 1.3-7.0 cm.
   H: 1.3-2.5 cm.
6. Dense titi, scattered pine.
   L: 2.5-10 cm.
   F: 3.8-10 cm.
   H: 5.0-7.6 cm.
7. Dense titi.
   Mat including growing low vegetation .61-3.7 meters thick.

Comments: The influence of live oak in developing the L layer is seen in example 1. In example 2 several centimenters of humus accumulated among the grass blades,

having sifted down from the overstory. Thus the humus is composed of an admixture of differently aged parts with no obvious stratification. The site providing example 5 is apparently less depressed than sites for examples 4, 6, and 7 which show the extent of accumulation of decaying and decayed herbaceous and shrubby vegetation in poorly drained places close to sea level. Here is displayed the entire genesis of such soil types as Pamlico muck and the major factor in the development of related types.

III. Peninsular Area (3 vegetation sites-3 variations).

A. Drier sites.

1. Scrub oak, sparse pine.
   - L: 1.3-2.5 cm.
   - F: 1.3-2.5 cm.
   - H: .64-2.5 cm.

B. Wetter sites.

2. Dense *Hypericum* and other water tolerant non-arboreal plants. No measurable litter.
3. Cypress swamp.
   - L: 2.5 cm.
   - F: 1.3 cm.
   - H: 1.3 cm.

Comments: Example 1 shows the influence of the scattered pines on the L layer and the influence of the scrub oak on the H layer. Example 2 shows the rapid rate of decay and disappearance of shrubby and herbaceous debris under better drained situations in contrast to the East Bay Swamp examples. The thickness of all layers in this example reflects drainage and evergreen persistence factors.

As indicated in the above survey, the development and persistence of humus is directly related to the vegetation type and drainage conditions, elevation exercising little or no control as was the case in the Ranger Training area in North Georgia. In those sites dominated by deciduous plants and fairly well drained, humus as a surface material or as

a soil factor of great importance can be ignored, its occurrence is at best transitory. In the wetter sites and in those where evergreens dominate or exert a contributing influence, humus could be an important consideration under certain conditions and prediction of its occurrence valuable to the success of an operation.

C. Visibility Study

In connection with the vegetation sampling at Eglin Field, an attempt was made to characterize each of several sites in terms of visibility as it is affected by growth patterns in the immediate vicinity of the sites.

Lateral visibility was determined by calculating distances along a paced straight line extending from the center of a vegetation sample site to some point where a man walking a zig-zag course without deliberately seeking cover was judged by an observer at the center point to be out of sight more than in obvious view. Except in instances where the site lay next to a broad clearing or perhaps a relatively deep and steep-sided ravine, the distance estimates for visibility followed the cardinal points of the compass. Where clearings and obstacles did interfere, the estimates were determined in those cardinal directions where vegetation was present or obstacles absent.

From approximately 35 visibility samples, 10 more or less

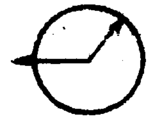
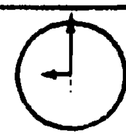
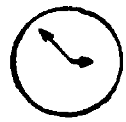
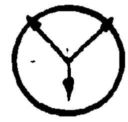
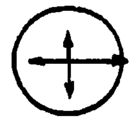
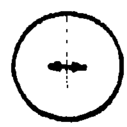
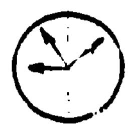
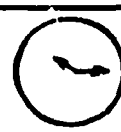
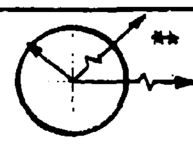
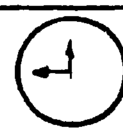
representative determinations are listed in Table 1. Vegetation site numbers are given for reference to Plate 8 and to the appropriate vegetation diagrams accompanying this report. Limitations imposed upon the over-all study did not permit a detailed quantitative assessment of the visibility factor in the Eglin area. The results obtained, however, appear to support the observations set forth in the following paragraphs.

The wooded tracts in the Ranger training area at Eglin Field are generally open. On the excessively drained interfluves, pine and shrubby oak stands are nowhere dense. The understory vegetation is sparse and scattered although clumped in places. Visibility in such stands ranges in the neighborhood of 70 to 90 meters except where clumped understory material obstructs the view. In the latter case, the distance at which an erect and moving man could be seen within the cover of summer foliage during full daylight was reduced to 30 to 45 meters.

Visibility in deep swamp areas occupied by large trees was inhibited more by reduced light conditions than by dense vegetation within 6 to 9 meters above the ground surface. In contrast, a pronounced edge effect resulting in the development of dense shrubby masses on the margins of openings such as along roads and streams reverses the importance of the two visibility factors. Visibility within the swamp areas covered by large trees was found to vary around 30-40 meters. Visibility

TABLE I

Selected Examples of Visibility Tests

Site	Location	Cover Type	Visibility Symbol*
1	Upland area south of Holley Creek.	Nearly pure pine, some scrub oak.	
4	Upland area south of Holley Creek, SW of Site 1.	Mixed pine and scrub oak.	
7	Upland area west of Little Boiling Creek.	Scrub oak, immature pine, grass, palmetto.	
53	Upland steephead: Indigo Head.	Hardwoods and magnolia.	
53a	Upland steephead: Indigo Head, SW of Site 53.	Magnolia.	
61	Upland steephead: Boiling Creek steephead near mouth.	Titi with scattered pine and white cedar.	
65	East Bay Swamp south of East Bay Church.	Titi-white cedar mixture.	
73	East Bay Swamp north of Holley.	Dense titi with scattered pine.	
37	Peninsular Area northwest of Wynnehaven Beach.	Sparse pine with low scrub oak.	
89	Peninsular Area northwest of Upper Prichard Point.	Cypress swamp.	

*Scale: 1"=160 m. Circle radii=50 m. **NE line=135 m.; due east line=360+ m.

in swamps with smaller tree cover was somewhat more restricted because of the greater number of stems supporting the cover. Visibility as measured ranged from about 15 to 40 meters.

The steepheads, being wet and humid elongated enclaves of the sandy uplands, have a much denser growth of vegetation. However, tightly meandering streams moving along the sandy floors of them, appear to maintain open places from which plants are regularly uprooted. Some of these plants become re-established, often in a tangled fashion with others. In places, this results in veritable mazes of living "brush." Dense growths of seedlings and pithy stemmed plants become quickly established in open areas near patches of muck. Tall, straight, and large-stemmed, broad-leaved trees are scattered along the steepheads. The combination of this variety of discontinuous cover types results in a wide range of visibility from around 5 meters to 45-50 meters. Near the heads of steepheads, magnolias along with oaks and poplars dominate. Here the ground surface is quite open as in the heavily shaded swamp areas and visibility increases to about 40 to 60 meters.

Hypericum stands were found to be quite dense except where larger cypress dominated. In pure *Hypericum* stands, visibility below 1.2 meters was found to be 5 to 7 meters.

The range of visibility conditions at Eglin field is illustrated in Figure 15. A view of the white sand of Santa Rosa Island is included

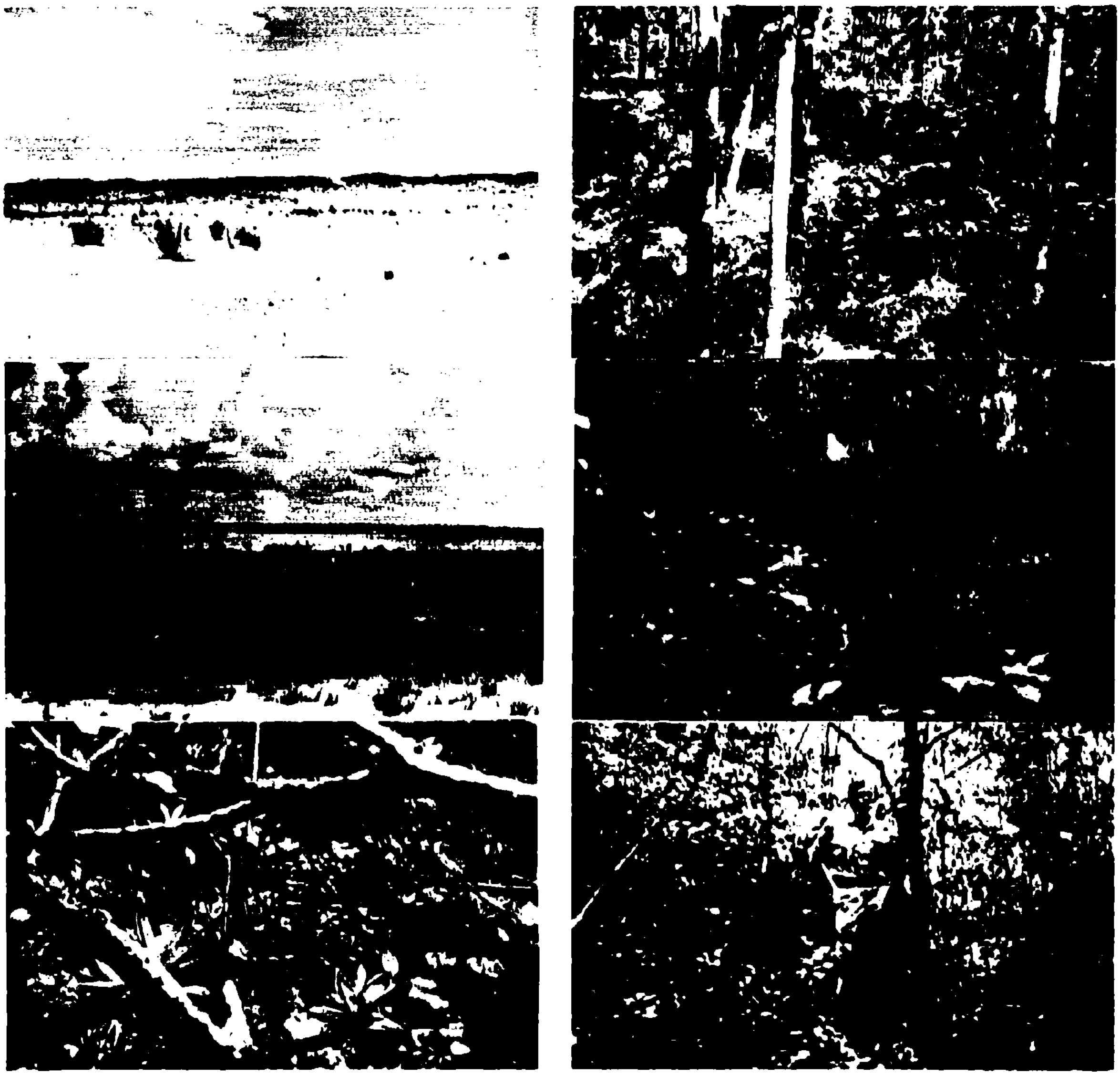


Figure 15. Range of visibility in the Eglin Field area. On the left, top to bottom, coastal duneland, marshland, and wooded upland. On the right, views in the steepheads.

since the glare of this sand, after prolonged exposure to it, is equal to any clump of vegetation in reducing visibility.

It is suggested by the results of this study that for many areas requiring certain military operations, a visibility index based on some sampling method such as described might be a significant addition to environmental information.

D. Cone Penetrometer Study

1. Introduction

For the purpose of providing a means for estimating vehicular trafficability, and for expanding the range of soils and other environmental information extracted from the Eglin Field area, cone penetrometer data were collected from selected sites during the course of the investigation (Figure 16).

Within the physiographic subdivisions represented at Eglin Field, two areas appeared to offer the best opportunity to collect potentially significant data: the section lying northwest, west, and southwest of Metts Lookout Tower in the more dissected upland portion of the Ranger training area where most of the changes in relief of any consequence are concentrated; and on Santa Rosa Island, which represents a distinct environmental complex with special features not found elsewhere in the area. In connection with the upland study, a special case was made of

Figure 16. Cone penetrometer data collecting, Santa Rosa Island.

Bombing Range 75, an impact area providing an opportunity to examine surfaces within the same section exposed to contrasting military use.

One sample was collected in the East Bay Swamp Area (grid coordinates 24.7 x 67.1). The average cone index value in the 6" to 12" layer for the site was 108. At this site there was a surface root mat 6.4 to 7.6 cm. thick under 1.3 cm. of leaves The conclusion reached was that in this area thick vegetation including large pine trees would hamper trafficability more than any lack of soil strength. Therefore, further testing appeared to be unwarranted and additional data were not collected.

The cone index values shown on the Trafficability prediction Data sheets, submitted under separate cover, were obtained using the 5/8" diameter staff and the 0.5 square inch cone.

Multiple sets of readings were obtained within a 2 meter circle at any one site and averaged.

2. Upland Area

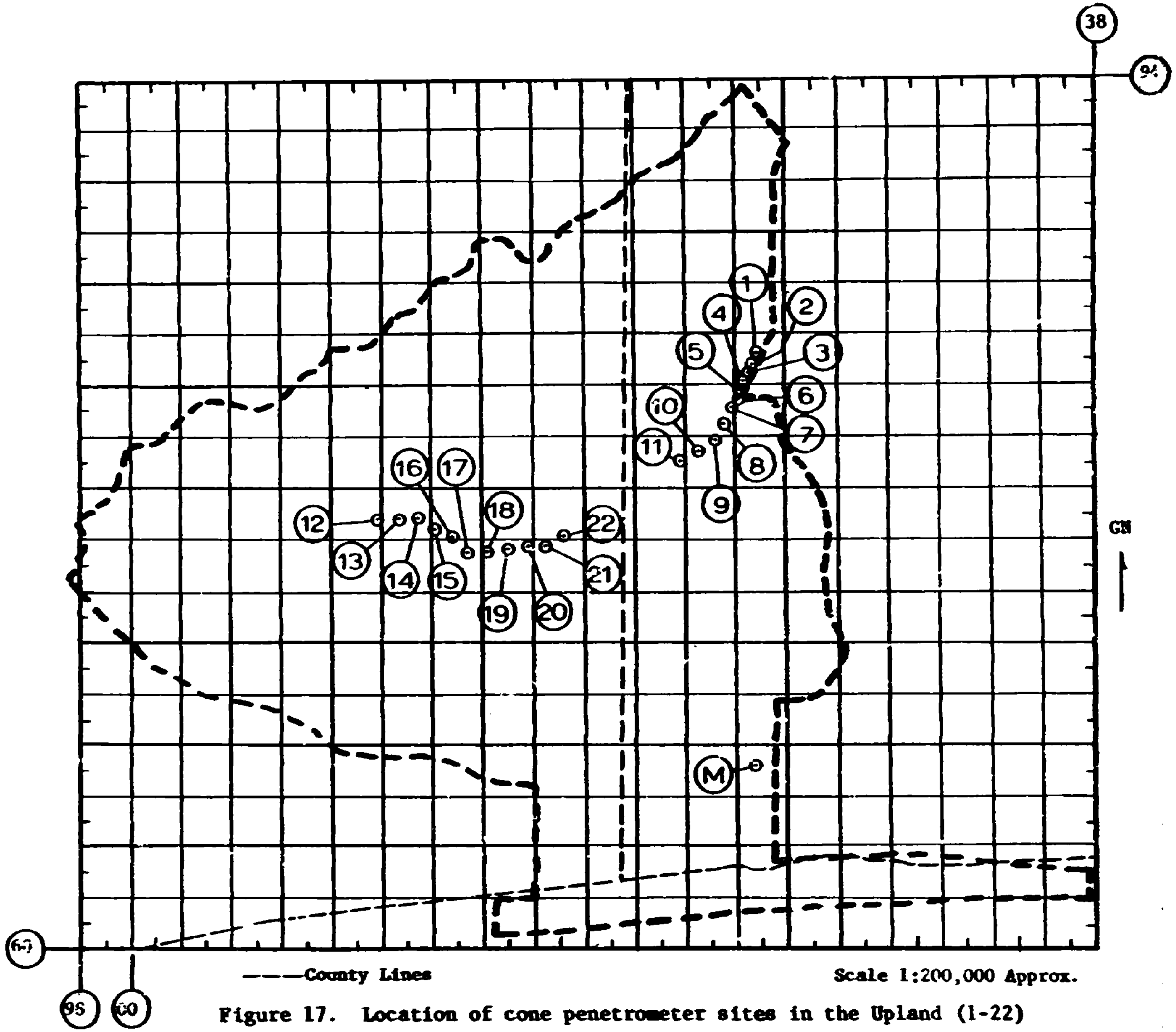
The data obtained at 24 sites is tabulated in Table II. These sites are located on Figure 17. All of these data were obtained on nearly flat sites. In the critical layer (6" to 12" depth) the range of cone indices was between 52 and 172 except for site 11A which had a range of 197 to 240. It was apparent that the cone index for site 11A was higher because of the movement of heavy equipment in years past.

TABLE II

Cone Penetrometer Index Averages, Upland Area

Sampling Transect A: Beginning with site #1 at grid coordinates 24.9 E - 83.2 N near Metts Lookout Tower and continuing along the road at one-fourth mile intervals to site #11 at grid coordinates 21.8 E - 79.1 N near Field #7. Sampling Transect B: Beginning with site #12 at grid coordinates 9.8 E - 76.9 N near Weaver Lookout Tower and continuing along the road at one-fourth mile intervals to site #22 at grid coordinates 17.1 E - 76.1 N near Field #7. A top layer of light gray sand 2.5 to 7.6 cm. deep overlies light yellow sand on most of generally flat to gently undulating surface.

Site No.	Elevation (ft.)	Depth of Readings			
		Surface	3"	6"	12"
1	170	12	84	118	151
2	170	20	107	99	72
3	172	13	103	103	72
4	172	22	114	91	52
5	180	27	105	102	71
6	190	27	113	119	86
7	180	17	92	91	79
8	160	27	92	80	77
9	190	21	147	162	118
10	161	42	84	65	62
11A	180	46	193	240	197
11B	175	25	95	83	64
12	121	31	97	99	82
13	130	29	110	108	98
14A	125	39	92	95	122
14B	125	30	82	118	128
15	121	85	161	96	118
16	116	25	124	137	122
17	110	22	95	100	88
18	110	150	99	112	117
19	112	18	74	105	140
20	112	16	82	82	110
21	113	26	120	172	122
22	121	19	90	102	92



----County Lines

Scale 1:200,000 Approx.

Figure 17. Location of cone penetrometer sites in the Upland (1-22) and East Bay Swamp (M) Areas.

The marks caused by such equipment could still be observed.

The range of cone index values indicates that there is no trafficability problem from a soil strength standpoint for most of the Army vehicles listed on page 24 of Technical Bulletin TB ENG 37 10 July 1959 entitled "Soils Trafficability."

Several sets of cone index data (Table III) were obtained within Bombing Range 75, northwest of Metts Tower. At the 15.2 cm. depth the range of cone indices was between 50 and 260 for 30 test sites 100 paces apart along the east-west road through the bombing range. The range of cone indices for 16 sites was between 50 and 170 which compares nearly exactly with the range of values outside the bombing range as given above. The range of cone indices for the other 16 sites was between 200 and 260. The bombing range was still being used as a live or hot range in the summer of 1963. This suggests that the bombings have compacted the soil in some places. There was also evidence of the movement of tracked vehicles.

3. Santa Rosa Island

Cone penetrometer data profiles extending from the sound to the Gulf of Mexico were obtained on Santa Rosa Island (see Plate No. 1). Data are listed in Table IV. Cone index readings were taken up the dunes and in the lows. At most locations, including dunes or lows, readings of 300+ were obtained at the 9" - 12" depth. Moisture content

TABLE III

Cone Penetrometer Index Averages, Bombing Range 75

Readings taken along east-west transect at 30 meter intervals beginning at the south edge of the range.

Site No.	Surface	Depth of Readings 3"	6"	12"	18"
1	10	140	210	300	300
2	10	80	90	120	120
3	20	200	260	260	260
4	20	180	240	200	200
5	40	70	60	80	110
6	20	50	200	220	220
7	30	130	140	140	120
8	40	100	130	170	150
9	40	220	260	260	240
10	30	110	220	200	180
11	10	200	200	220	220
12	20	140	200	140	180
13	20	160	240	280	220
14	20	140	240	280	280
15	20	110	170	160	140
16	10	140	240	200	150
17	30	80	120	130	100
18	20	60	50	100	220
19	10	70	80	160	180
20	40	110	170	210	200
21	20	100	200	200	180
22	25	60	160	180	180
23	25	80	85	100	110
24	20	120	120	120	110
25	20	145	225	180	140
26	20	40	95	85	85
27	20	150	200	210	140
28	30	140	170	120	130
29	5	60	85	90	20
30	20	60	130	150	150

TABLE IV

Cone Penetrometer Index Averages, Santa Rosa Island

Dune or Low Site		Depth of Readings							Moisture Content*	
No.	Description	Surface	3"	6"	9"	12"	15"	18"	0-6"	6-12"
A-1	Dune: Lee side; Slope-25°	12	41	90	127	134	142	135	3.7%	4.2%
A-2	Dune: Windward side: Slope-29½°	9	90	190	288	300+			3.0%	3.2%
A-3	Low: Water table at 8"; Slope-0°	14	98	228	292	300+			21.9%	22.5%
A-4	Dune: Lee side; Slope-6°	12	151	260	300+				3.6%	4.3%
A-5	Dune: Lee side; Slope-16°	21	90	145	256	300+			2.8%	3.2%
B-1	Low: Water table at 9"; Slope-½°	28	83	124	198	300+			21.2%	25.0%
B-2	Low: Water table at 11"; Slope-0°	15	94	159	203	226	257	281	15.3%	21.2%
B-3	Dune: Lee side; Slope-11°	13	108	161	267	300+			3.2%	2.7%
B-4	Dune: Lee side; Slope-22°	12	75	143	249	300+			4.0%	4.0%

TABLE IV (Continued)

Cone Penetrometer Index Averages, Santa Rosa Island

Dune or Low Site		Depth of Readings							Moisture Content*	
No.	Description	Surface	3"	6"	9"	12"	15"	18"	0-6"	6-12"
B-5	Dune: Side normal to wind; Slope-18°	16	134	242	300+				5.1%	5.1%
C-1	Dune: Lee side; Slope-25°	0	25	53	61	97	147	176	3.2%	2.6%
C-2	Dune: Wind-ward side; Slope-11°	19	93	182	292	300			3.4%	4.3%
C-3	Dune: Wind-ward side; Slope-17°	3	61	150	235	292	300+		3.4%	4.7%
D-1	Low: No water in top 18"; Slope-0°	23	90	152	207	241	250	238	Not determined	
D-2	Dune: Lee-ward side; Slope-9½°	17	42	103	188	196	219	218	"	"
D-3	Dune: Lee-ward side; Slope-13°	8	80	233	277	300			"	"
D-4	Dune: Wind-ward side; Slope-0°	3	91	178	254	292	300+		"	"

TABLE IV (Continued)

Cone Penetrometer Index Averages, Santa Rosa Island

Dune or Low Site		Depth of Readings							Moisture Content*	
No.	Description	Surface	3"	6"	9"	12"	15"	18"	0-6"	6-12"
E-1	Dune: Leeward side; Slope-28½°	0	6	55	99	192	216	238	Not Determined	
E-2	Dune: Windward side; Slope-9°	0	43	173	284	300			"	"
E-3	Low: Water table at 7"; Slope-0°	18	46	138	204	240	268	300	"	"
E-4	Low: Water table below 18"	6	64	126	141	144	186	263	"	"
E-5	Low: Water table below 18"; Slope-0°	2	80	79	117	122	223		5.3%	4.9%
E-6	Low: Water table at 18"; on Gulf beach	12	44	100	97	133	233	290	11.0%	19.0%

$$\text{*Moisture Content} = \frac{\text{Moisture in Grams}}{\text{Dry Weight - Tare}} \times 100$$

in the lows, some of which were less than 30.5 cm. above the water table, and on the beach adjacent to the Gulf ranged between 19% and 25%. The dunes were higher and drier as one would expect. Moisture content for the dunes varied between 3% and 5%. A comparison of moisture content between dune and low samples is shown in Table V.

Trafficability on Santa Rosa Island would probably be affected by the slopes of dunes, spacing of dunes, and vegetation more than by soil strength. Four-wheel drive vehicles are definitely required.

TABLE V

Comparison of Moisture Content Santa Rosa Island

Samples	Moisture Content	
Lows:	0-6" Layer	6-12" Layer
A-3	21.9	22.5
B-1	21.2	25.0
B-2	15.3	21.2
Dunes:		
A-1	3.70	4.17
A-2	3.02	3.21
A-4	3.57	4.28
A-5	2.75	3.21
B-3	3.18	2.72
B-4	4.00	3.98
B-5	5.07	5.05
C-1	3.19	2.58
C-2	3.38	4.32
C-3	3.84	4.69

E. Hydrology and Hydraulic Geometry

1. Introduction

Few if any aspects of environment at Eglin Field could be discussed without direct or indirect reference to water. It is quite possible that the most important surface in the area is the water table from any point of view. Since it is apparent that hydrologic factors exert a powerful influence over much of the environment at Eglin Field (Figures 18 and 42), a detailed study would be in order in a report of this kind. However, time and other limitations permitted only general observations in the field. Even so, it seems appropriate, in view of the relative importance of the subject, to present the following collation of available hydrologic information concerning Eglin Field and the surrounding area along with certain conclusions reached from field experience.

Matson in Matson and Sanford (1913) briefly discussed the hydrology of the area by counties but little subsequent information appeared until the recent publication of Musgrave, Barraclough, and Marsh (1961) on the water resources of Escambia and Santa Rosa Counties. Many of the hydrologic details presented here are abstracted from the latter publication.

2. Precipitation

Data collected by the U. S. Weather Bureau at Pensacola provide

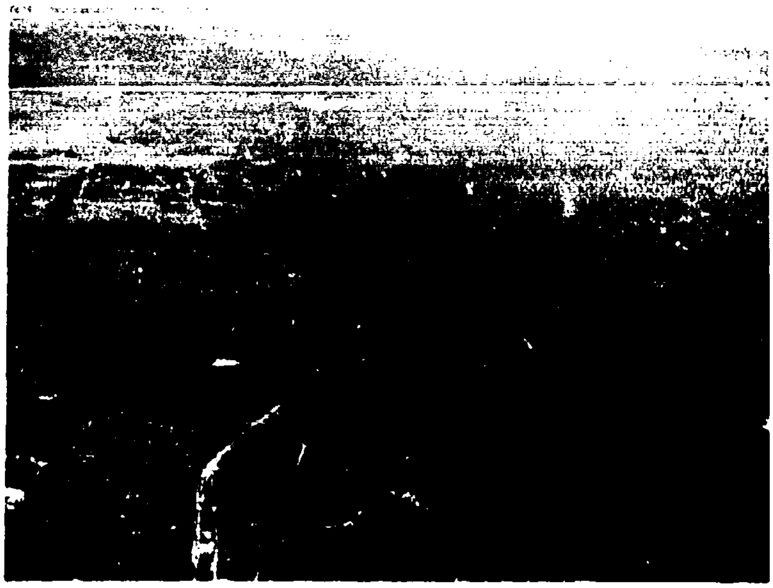


Figure 18. Major hydrologic features, Eglin Field area, Florida.

the longest continuous record of rainfall in the area and can be used to plot a reasonably predictable hydrologic curve for the whole section of West Florida bordering the coast. Based on a 33-year period (1926-1958) the average rainfall in the area is 62.17 inches. However, the year-to-year variation is sometimes extreme. For example, the highest and lowest annual rainfall during the period occurred at Pensacola in successive years, 90.41 inches in 1953 and 28.66 inches in 1954.

The wettest periods (6in.+) occur in early spring (March) and late summer (July, August, September) with July having the highest rainfall (7.4 in.). The driest periods occur during October (2.9 in.) and November (3.8 in.). Except for the latter, at least 4 inches of rainfall can be expected on the average each month. A very significant aspect of rainfall in the area is the not uncommon high intensity. As much as .6 inch in a five-minute period, 3.5 inches during a 1-hour period and 6.0 inches in a 24-hour period have been recorded in the area. Monthly temperature highs and lows very nearly correspond to wet and dry periods, respectively. Furthermore, the fluctuation in number and intensity of the hydrologic factors operative in the area shows similar correspondence.

3. Surface hydrology

As discussed in previous sections, two major streams of unequal proportions cross the surface in the Eglin Field area, the Yellow River

and East Bay River. The Yellow River flows in a generally southwestern direction within the easternmost of four major drainage basins converging radially upon Pensacola Bay and its extensions. The Yellow River drainage basin covers an area of 3538 square km. but only about 299 square kms. of the basin is developed in the Eglin Field area and immediate vicinity. Therefore, very little surface runoff in the Eglin Field area contributes to the average flow of 2500 cfs. into Blackwater Bay. The major branches of the river are joined in northern Okaloosa County east of Eglin Field from sources in the northeastern portion of that county (Shoal River and tributaries), and in southeastern Alabama. The main channel winds through a heavily wooded and swampy floodplain averaging 3.2 km. miles in width. Westward beyond the junction of the principal tributaries as the river flows along the northern boundary of the Ranger area, the few, small, poorly developed tributaries head almost exclusively in the steepheads discussed previously in connection with other features of the area. Within the steep sides of the steepheads the channels of these tributary streams are narrow and shallow with generally sandy and flat bottoms except in meanders. Figure 19 shows the locations and cross-sectional profiles of several of these channels measured during the course of the investigation. No continuous stream flow data for these tributaries and the Yellow River itself have been recorded and published since 1941 in the

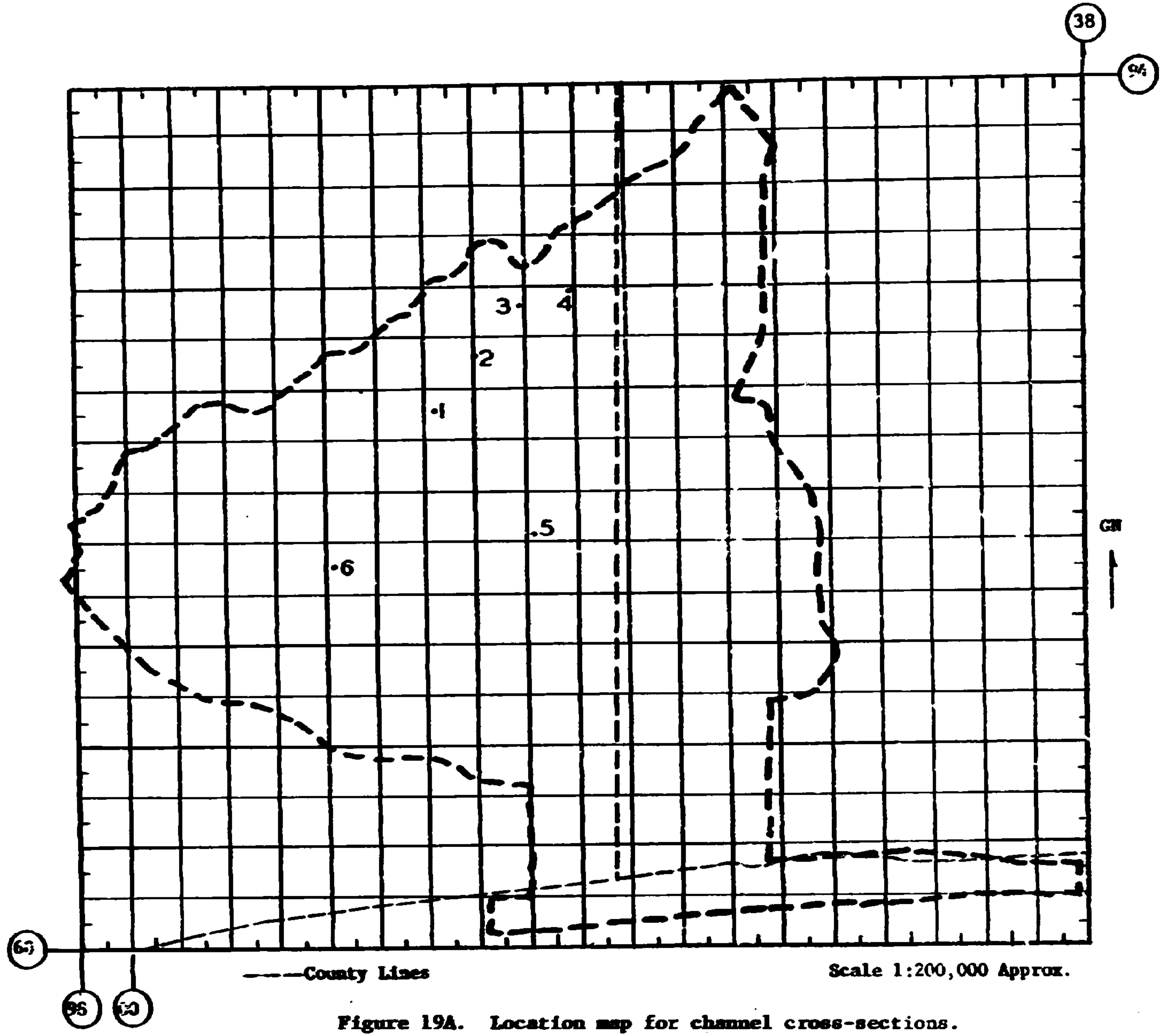


Figure 19A. Location map for channel cross-sections.

Figure 19B

Hydrologic Cross-sections, Eglin Field Area

SCALE: Vertical 1" = 1 meter
Horizontal 1" = 10 meters

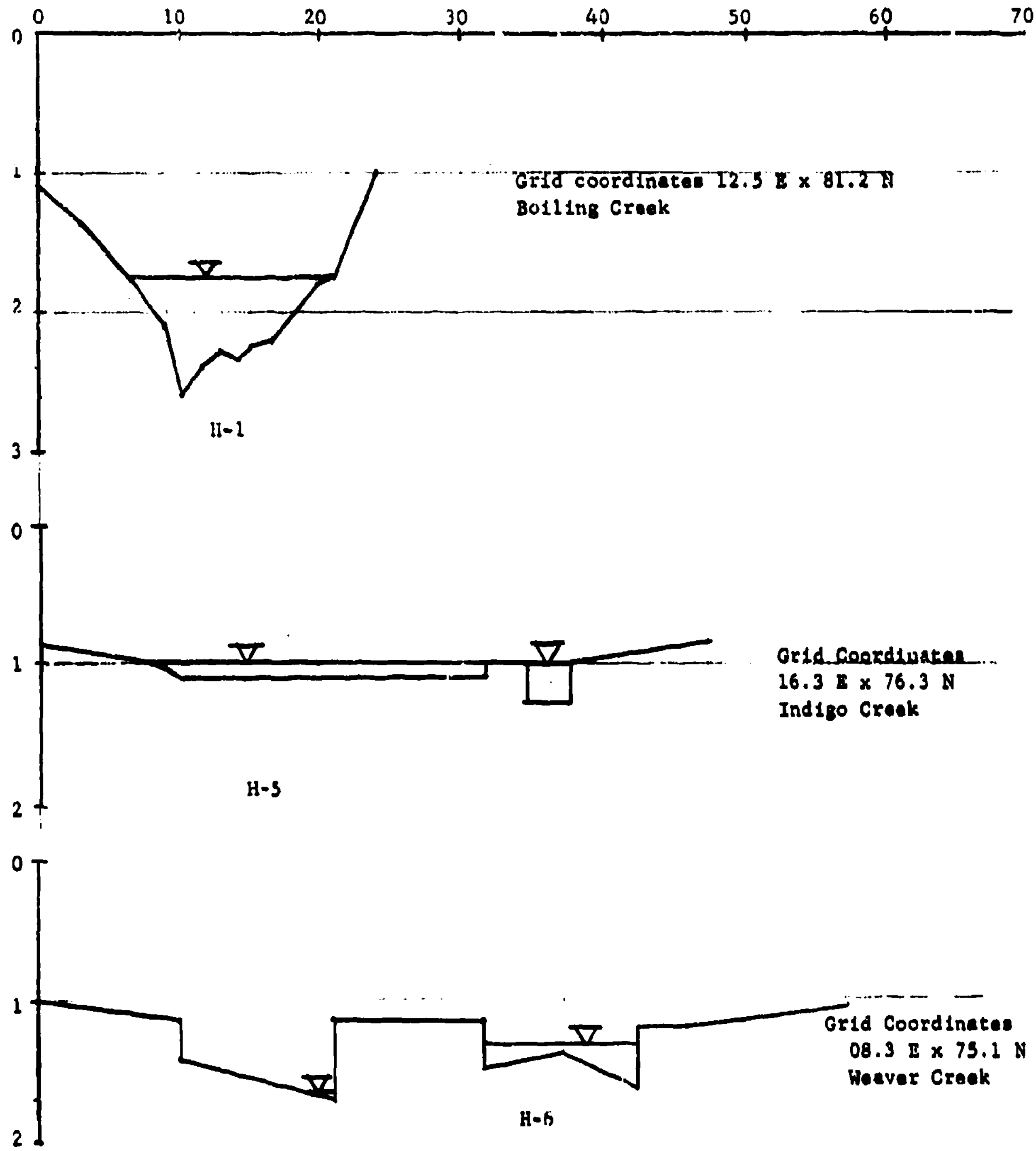
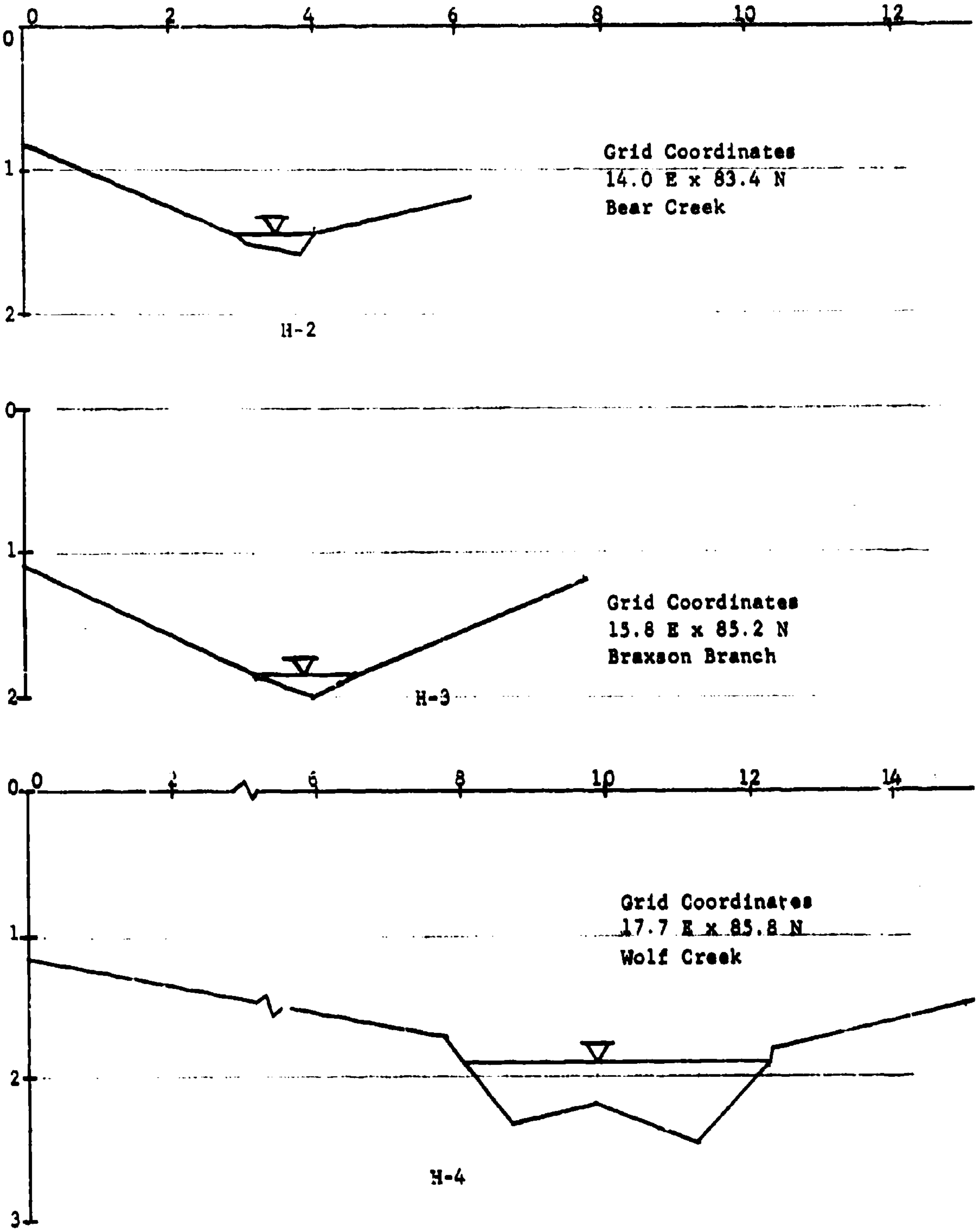


Figure 19B (Continued)



SCALE: Vertical 1" = 1 meter
Horizontal 1" = 2 meters

general area. A station at Holt, Okaloosa County was reactivated in 1961 but information was not available at this writing.

North of horizontal grid line 75, all streams in the Ranger area flow into the Yellow River. The poorly branched East Bay River flows through East Bay Swamp on a very low gradient after forming principally from two south-flowing branches originating in southwest Okaloosa County. This river and a few small unconnected streams flowing out of the southern escarpment of the Upland section empty directly into the East Bay embayment. Between these systems, a very large portion of the Ranger area has no apparent surface drainage.

The lower reaches of the Yellow River are characterised by several estuarine channels and associated marshland extending into the floodplain from Blackwater Bay. In most of the Ranger area, numerous cut-off channels leave the main channel to re-enter farther downstream. From the Gulf and its embayments, salt water wedges extend varying distances up the streams, as much as 32.2 km. in the case of the Yellow River. The saltwater front is pushed inward to a maximum during times that low stream flow coincides with seasonal high tides. Thus, seasonal fluctuations in this regard closely follow the rainfall pattern.

No records were available for specific flood levels in the Eglin area although periodic flooding is anticipated by local residents and personal accounts are commonplace. First bottom development along the

Yellow River attests to the extent of these floods. In the immediate vicinity of the Eglin area, floodwater stages of some smaller streams are known to vary as much as 4.6 meters, and the fluctuation of larger streams as much as 11 meters. Poor drainage becomes extremely so following intense and prolonged rainfall. Most streams in the Eglin area respond very quickly to rainfall.

4. Subsurface hydrology

Water penetrating the surface in the Eglin area, and most of it does owing to the character of the surface materials, is confined to a zone lying above a thick clay unit that serves to separate the thick sequence of sand, gravel, and clay above from the well-known limestone artesian system of Florida below. The upper zone reaches a thickness of approximately 305 meters in the center of the Eglin area thinning northeastward to a thickness of 107 meters north of the Yellow River boundary. A well drilled at Holley, reaching 323 meters in depth, penetrated the limestone aquifer between that depth and 218 meters. The superimposed aquifer of sand and gravel recharged directly from the surface, is the source of the water producing the major hydrologic effects in the Eglin area. The surface of this aquifer is the surface of the Eglin terrain.

The most important characteristic of the sand and gravel aquifer is that, although it is composed predominantly of sand and silty sand as

previously noted in the consideration of surface materials, abrupt changes in lithology are common in the subsurface. Lenses of clay and gravel occur at varying depths from the surface, in irregular thicknesses, and extend shorter to longer distances. Where pairs of lenses or layers of relatively impermeable clay or silty clay are separated by sand and gravel, conditions for the development of local artesian systems exist. Where single layers occur at or near the surface, a perched condition results. The latter effect is likewise produced by the development of hardpan or ortstein layers common to some of the soil types discussed in a previous section. As a result of these variations in ground water occurrence, it is nearly impossible to reconstruct a common piezometric surface for the area.

One or the other of the conditions discribed above is responsible in the Ranger area for the ponding of water which remains except for evaporation or slow loss through percolation; most instances of poor drainage and consequent results; rapid saturation of certain soils following rains and subsequent rise in water levels near or above the surface to create standing water situations; the occurrence of lateral seepage into depressions formed through deflation or subsidence; and the emergence of springs where such a condition is intersected by slopes or vertical cuts. The latter is apparently responsible for the development of the most outstanding terrain feature of the Eglin Field area, the steepheads.

Within the steephead canyons, notched into the Upland surface, the tributary streams of the Yellow River cited previously owe their existence to springs emerging along clay or hardpan layers at the heads of the canyons. A general coincidence of depth of the canyon heads suggests an impermeable layer common to all the steephead streams. There is little evidence to support any direct connection between surface runoff and the development of the steepheads. Subsurface flow and erosion, followed by collapse and removal, may have been responsible for their origin. Subsequent enlargement and lengthening by spring undermining at the feet of the boundary slopes appear to be at least partly if not entirely responsible for these phenomena. The Bossorocas in Brazil described by Terzaghi (1950) may be a possible analog. The head slope profiles of the major Eglin steepheads bear close resemblance to slide surface profiles.

III. MACROGEOMETRY

A. Elongation Number

The Eglin elongation numbers while being roughly normally distributed tend to both cluster densely about the mean of 0.449 and spread toward the limits of zero and one. Their distribution is shown in Figure 20 but it does not include any values for the area south of East River. These and the other Eglin macrogeometry parameter values were treated as a spot sample from a large population of terrain very similar to that of the Ranger training area at Eglin Air Force Base, Florida. (The several terrain unit parameters of the Dahlonega, Fort Benning, and Eglin areas are compared in the Summary Report, Part 3, Section B; also see "Eglin Miscellaneous" on Plate 5 and Plate 2.

B. Relief

The relief in the Eglin area is small, as one might expect along a coast of this nature, with a maximum of little more than 200 feet. Relief here like elsewhere is found in diverse forms varying from cliffs of perhaps 75 feet and difficult to scale to easily traversed gentle slopes. Figure 21 shows that most of the average relief values lie between twenty and one hundred feet. Those terrain units which are atypical with respect to relief at about the 5% lower and upper levels among the sample group are outlined on Plate 3.

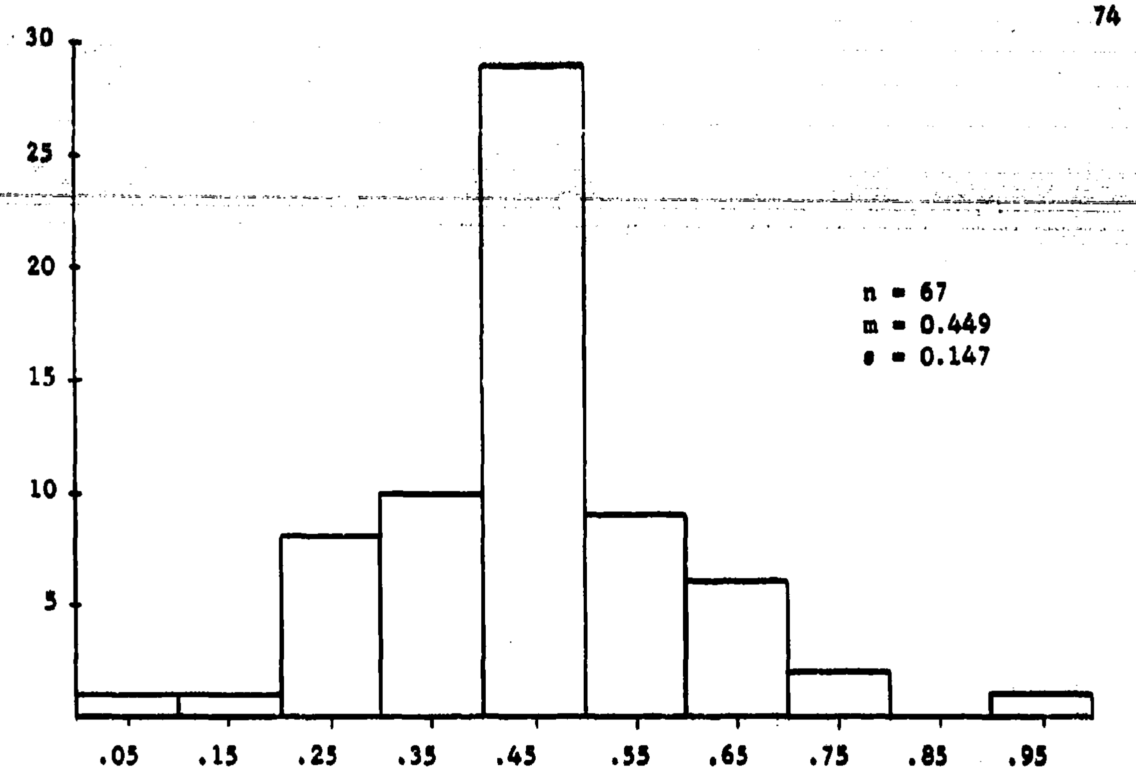


Figure 20. Frequency distribution of sample terrain unit elongation numbers, Ranger training area, Eglin AFB, Florida.

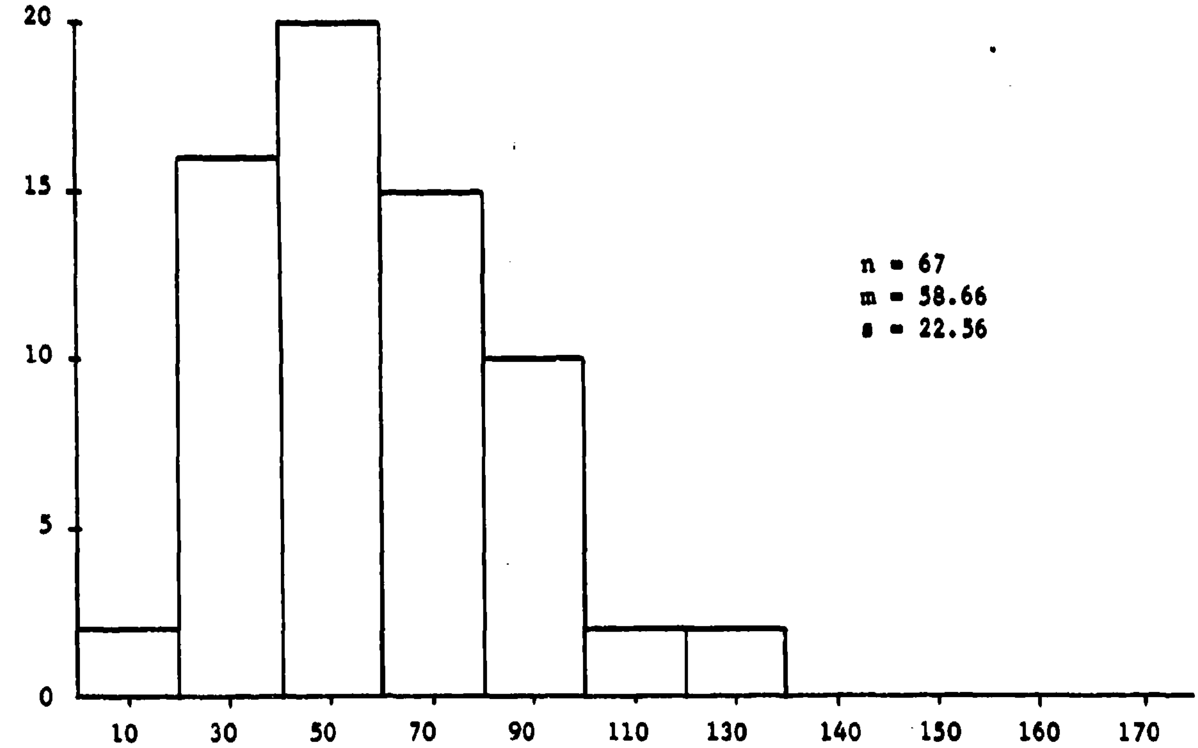


Figure 21. Frequency distribution of sample unit relief (in feet) values, Ranger training area, Eglin AFB, Florida.

C. Dissection

The Eglin D-values skew so much (Figure 22) that they must either be transformed before the variance and standard deviation can be determined for them or else some appropriate model must be found for them. (See the summary report for a brief discussion on models.) While a logarithmic transformation is used, it is not something to be used on any skewed distribution that one is likely to encounter. As Figure 23 shows, however, the transformation is quite good.

The "pancake" like terrain units of the Eglin area yield large D-values which indicate a relatively small amount of dissection. This is of course true for the area as revealed by either published topographic maps or field reconnaissance. Those sample units which lie in the lower and upper ranges, about 5% each way, in terms of average dissection values are outlined on Plate 4.

D. Profile Area

The Eglin profile areas were not calculated except for several arbitrarily selected terrain units which are shown in Table VI. The A-values for these six units plus the large unit south of East River, number 11-65, like other profile area values cluster around a mean of about 0.5. These units are outlined on Plate 5 "Eglin Miscellaneous."

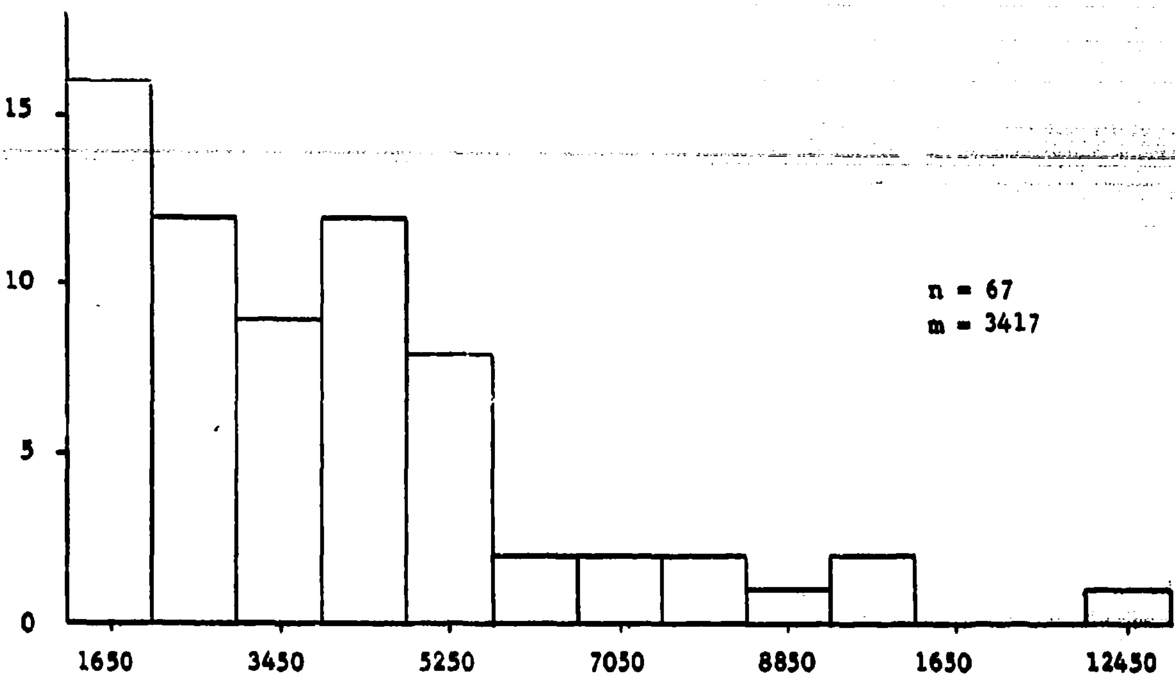


Figure 22. Frequency distribution of sample terrain unit dissection (in feet) values, Ranger training area, Eglin AFB, Florida.

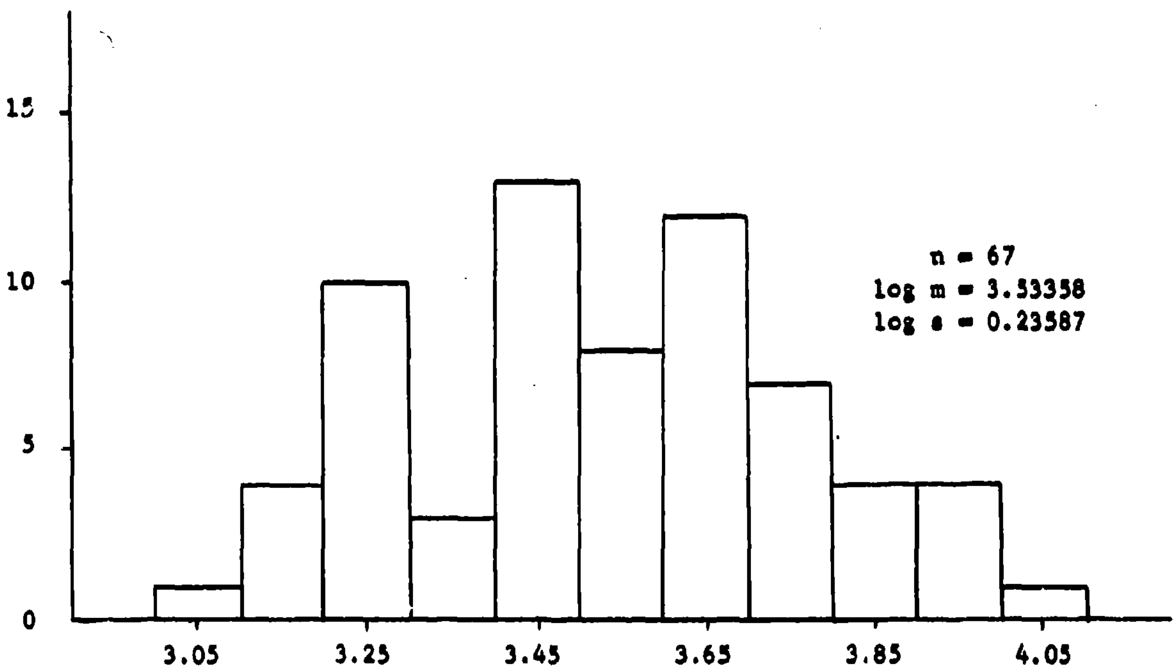


Figure 23. Logarithmic transformation of sample terrain unit dissection (in feet) value, Ranger training area, Eglin AFB, Florida.

E. Peakedness Index

Only seven S-values were calculated for the Eglin area. They are shown in Table VI and Plate 5. As one would expect for broad flat terrain units, the S-values are quite small.

F. Slope

This set of numbers, referred to as θ-values, was determined from the ratios of the R and D-values for each terrain unit. Though the average amount of slope in the Eglin area is very small, parts of some of the units are bordered by very steep sided gulleys as mentioned above in connection with relief. The three highest θ-values shown in Figure 24 and outlined on Plate 6 come from small terrain units which are partly bounded by such gulleys.

G. Parallelism Number

The parallelism numbers, referred to as α-values, are so irregular in their distribution that they defy the fitting of any model from which a prediction interval can be determined; thus, there is no plate for these values. Figure 25 shows this irregularity graphically.

H. Determination of Terrain Unit Parameter Values

The Vanderbilt method for locating terrain units proved to work as well for the coastal Eglin area as for any other area studied with the exception that a part of the boundary of some units was difficult

TABLE VI

Profile area and peakedness index values for a selected group of terrain units, Ranger training area, Eglin AFB, Florida

Terrain Unit No.	A-value	S-value
20-71	0.337	0.022
15-73	0.446	0.014
22-82	0.460	0.020
05-76	0.608	0.014
11-78	0.668	0.007
14-80	0.562	0.029
11-65	0.458	0.011
	$\bar{A} = 0.506$	$\bar{S} = 0.017$

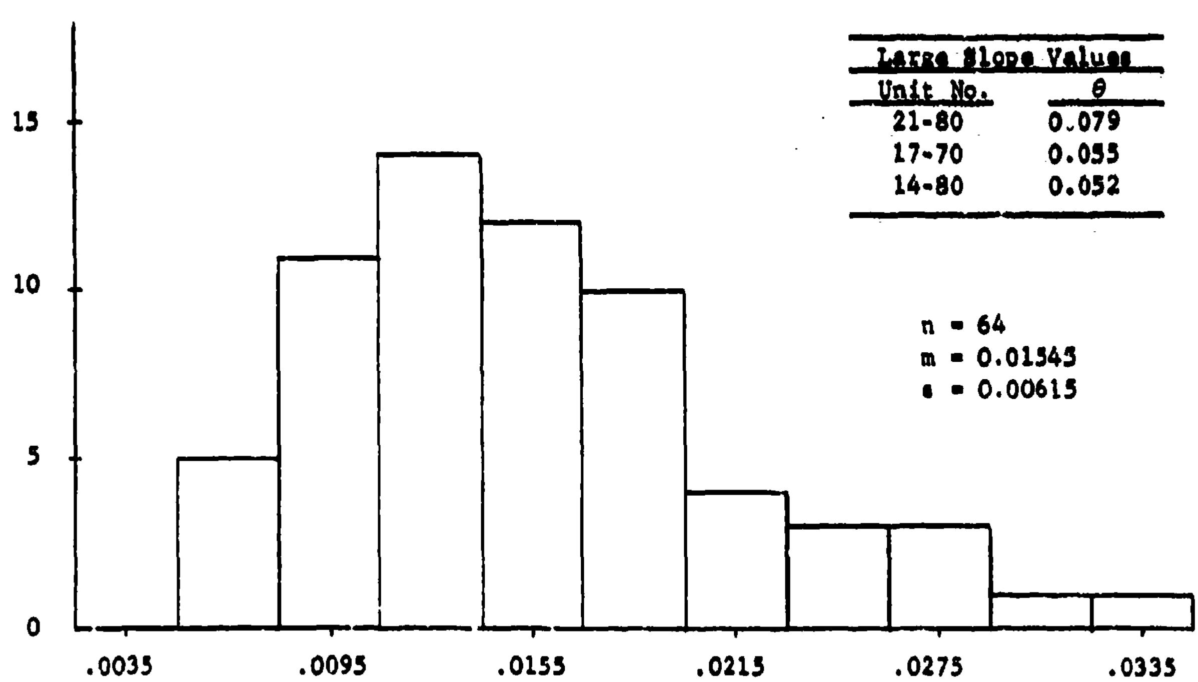


Figure 24. Frequency distribution of sample terrain unit slope numbers, Ranger training area, Eglin AFB, Florida.

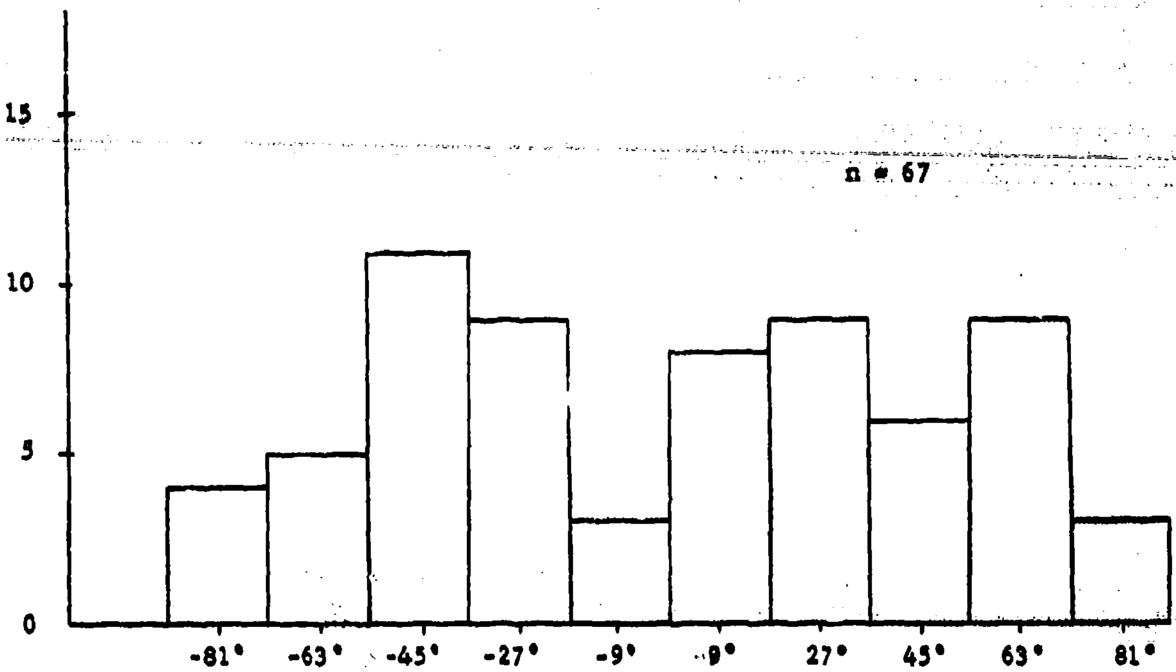


Figure 25A. Frequency distribution of sample terrain unit parallelism numbers (in degrees from north), Ranger training area, Eglin AFB, Florida.

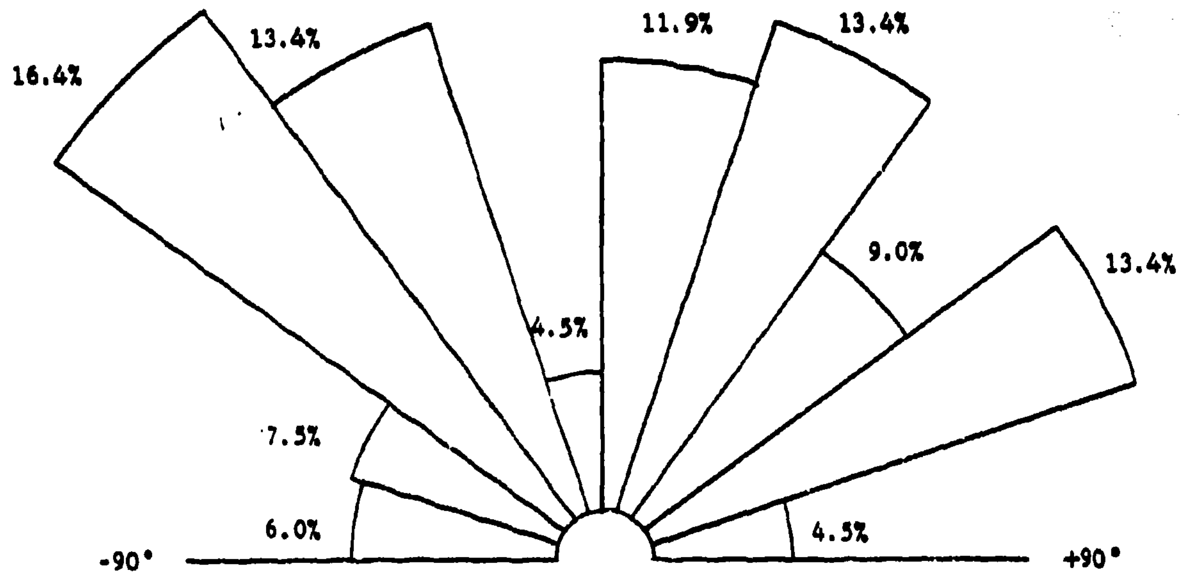


Figure 25B. Directional rose of sample terrain unit parallelism numbers (in degrees from north), Ranger training area, Eglin AFB, Florida.

to determine. Virtually all subjectivity could be eliminated by setting up a brief written procedural outline so that all using the method would proceed along similar lines.

Only four rays were used to determine the terrain unit parameter values in the Eglin area. Rays were first drawn from the unit high to the unit boundary low point and to the unit boundary high point respectively. Two additional rays running in opposite directions were drawn from the unit high bisecting the two angles formed by the first two rays. The R and D-values were determined from the four rays and the slope (θ-value) was determined from the ratio of the resulting R and D-values. S-values (peakedness index) and A-values (profile area) were not determined except for a few selected units. Elongation and parallelism numbers were determined in the same manner as for the Dahlonega area. (See Part 1, pages 77-80.) No terrain units were determined for Santa Rosa Island.

IV. VEGETATION

A. Objectives

The major objectives of this portion of the work were:

(1) to continue a study of the physiognomic structure and organization of vegetation, in particular, that at Eglin Field,

(2) to record and report by means of the WES-standardized system of diagrams the variation in and among the several kinds of plant communities present,

(3) to construct a map showing variations of the vegetation, accordingly as these might relate to military interests, especially those of the foot soldier.

B. Recent Vegetational History

About three-fourths of the higher terrain is presently covered by forest, woodland, or savanna in a variety of stages of development and conditions. Airports, bombing ranges, seedling plantations, and old fields cover the remainder of the upland. The low areas along the Yellow River, East Bay Swamp, and Santa Rosa Sound support a mixture of wet vegetation types which includes swamp forests, tall thickets, marshes and meadows. Santa Rosa Island is a narrow sand strip having on the gulf

side a well defined area of fore-dunes with tall grasses. Behind the dunes are areas sparsely populated with a mixture of low grasses and forbs, and scattered small patches of shrubs, savanna, and marshland. Subsistence farms are occasional along portions of the only public highway through the Reservation area, and both permanent and seasonal cottages are scattered along shore lines, except on the island.

Two areas distinguished by Harper (1914), were the West Florida Pine Hills and the West Florida Coast Strip. The former was characterized by open forests of longleaf pine and on the driest uplands by a mixture of pine and "blackjack oaks." Numerous gradations between dry and wet pine-land existed, and the wet slopes of the broader branch-valleys were reported as supporting a bog or "wet pine-barren flora more richly developed here than elsewhere in Florida." Lumbering and working for naval stores had been occurring since 1835, but as late as 1910 only about 3.6% of the area had been cleared. The Coast Strip included the islands and narrow peninsulas along the coast, and occasional brackish marshes near the mouths of mainland streams. The marshes were treeless, as were the moving dunes. Stationery dunes nearest the coast had a sparse growth of slash pine and evergreen shrubs, and the highest and oldest dunes supported a growth of longleaf pine and "blackjack" oaks.

Braun (1950) treats the vegetation as a series of types under the heading of Pine and Oak-Pine Forest Communities of the Southeastern

Evergreen Forest Region, pointing out that Harper's 1914 West Florida Pine Hills category is contained within the broad southern belt of longleaf pine forest. She too points out that very slight topographic differences lead to diversity of stands, and that all gradations exist between pure longleaf pine forests, the two storied pine-oak forests, and the scrubby oak communities.

On June 27, 1940, the Choctawhatchee National Forest was transferred to the War Department for development and operation as an Army Air Corps Proving Ground and was subsequently named Eglin Air Force Base. The transfer to the Military resulted in several changes, including the withdrawal of approximately ten per cent of the area for auxiliary air fields, bombing ranges, roads, power lines, and other administrative uses. Since 1947 a sizeable portion of the gunnery and bombing ranges have been returned to the Forestry Management Branch of the Air Force Base for reforestation and a total of 14,000 acres (Spence 1962) have been planted to slash pine seedlings. Harvesting is managed on a multiple use basis in conjunction with plans by the Fish and Wildlife Divisions, and the over-all plan is subject to one complete revision at least every ten years.

Seven vegetation types, of which five have merchantable lumber, are recognized by the Forestry Management Division of the Air Base according to Spence (1963). These are longleaf pine - ridge type, long-

leaf and slash pine - flatwoods type, slash pine-titi type, sand pine type (rare in the Ranger Training area), hardwoods type (lumped since the merchantables occur in roughly similar habitats), titi (thicket) type, and old fields.

C. Methods

1. Introduction

Although the main objectives sought in each of the Ranger Training Areas were the same and the general kinds of activities were unchanged, several modifications in procedures developed during the course of the second year's work.

2. Data Forms

A reconnaisance trip made prior to the field season disclosed that the vegetation of the area was diverse and included many additional types of plants not previously treated in the D[illegible] [illegible]. The simplified form for recording sampling data [illegible] [illegible]ecifically for use at Dahlonega was therefore scarcely a[illegible] [illegible]urther, a modification in the system of standard vegetation rec[illegible] symbols was announced by Addor (1963) recognizing a new range of [illegible]ss sizes of crowns in place of the former single fixed size; so a new field recording-form was devised and is included, Figure 26.

The metric system was used for the sizing values, and wherever possible multiple ranges were assigned class values. In this way

VEGETATION DATA SHEET

Sample No. _____ Diam. _____ Aerial Photo No. _____ Date Crew _____

Elevation _____ ft. Slope _____ % Toward _____ Map Coordinates _____

Use class range symbols to indicate characteristics.

CROWN — Diameter Class: 1 < .5M; 2 .5–2M; 3 2–6M; 4 6–15M; 5 > 15M

STEM — Diameter Class (Cms.): 1 < 2.5; 2 2.5–7.5; 3 7.5–15; 4 15–30; 5 30–60; 6 > 60. Hardness: Woody; Non-woody (Green, Non-Green)

BRANCH FORM — Lowest: 1 < .5M; 2 .5–1M; 3 1–2M; 4 2–3M; 5 > 3M

PLANT BASE — Emergence Class: 1 .3–.6M; 2 .6–2 M; 3 > 2 M. Spread: a 2–5 X; b 5–15X; c 15–45X; d > 45X

LEAF — Size Class: 1 < 15Cm²; 2 15–1500Cm²; 3 > 1500Cm². Texture: D-Dead; L-Living (Note in special if absent)

SPECIAL FEATURES

Distribution of plants

Position of:

- Spines – S_1 (less than 5 mm.)
- Spines – S_2 (more than 5 mm.)
- Cutting edge – C
- Stinging – St
- Poison – P

Epiphytes (Note ht. of attachment)

Slash (Record ht. of mass, and length and diameter-class range of stems)

Number of Plants	Height Class (1-8)	Crown Shape: Round	Flat	Pointed	Spindle	Irregular	Conforming	Crownless	% Cover	Stem Habit: Erect	Decumbent	Twining	Free	Woody	Succulent	Non-succulent	Fungi	Branch Type: Horizontal	Divergent	Plant Base: Stilts	Enlarged	Plank	Buttress	Leaf Shape: Broad Flat	Long Flat	Awl	Thread	Texture: Filmy	Membranous	Hard	Succulent	Special Features

Figure 26. Field sample form for recording vegetation.

ratings of approximately twenty-five kinds of attributes for each structural element could be entered on a single line, and a single page could hold a very large amount of data.

3. Choice of Sampling Areas

Aerial photos with scale of 1:20,000 were available for study and were used before the summer field work began. The photos had good overlap and were fair prints but included parts of four different flights made at different times. A very little part of the area was represented on two ages of photos, and these were both of more recent dates. About two-thirds of the photos were taken in 1949, and it turned out that these were rather badly outdated by changing ground conditions. A number of ground photos obtained during the pre-season reconnaissance trip proved helpful in study when used with the aerial photos. On the aerial photos the low wetlands vegetation types could be readily distinguished from those of the uplands but interpretable internal differentiation certainly was not obvious. Variability and pattern were evident but structural organisation of the vegetation was not. For these reasons a series of areas were chosen early for field study, the photos were taken along into the field, and the crew had the definite problem of discovering on the ground those attributes of the vegetation which contributed to the apparent variability on the photos. The problem of mapping types was raised early.

4. Sampling Procedure

In the field visual inspection was employed in locating the initial samples in what appeared to be representative portions of vegetation types as suggested from the photos. Later, samples were collected to add additional information about the types chosen as mapping units and to obtain answers to particular questions about vegetation structure.

In sampling practice, circular, nested, variable radius plots were constructed about a common center. The center was mainly some readily visible object, often a plant, sometimes simply a range pole or other stake. When the center point was a plant, it was not necessarily of the cell determinant type. Structural elements having local dominance, or at least prominence, were generally employed as "cell determinants" and were counted and recorded in areas of successively increasing radius in order to find the minimum structural cell size for the determinant in reference. Units of radial increase were two and one-half meters, and in most cases determinants consisted of single structural elements. Area-per-individual was recalculated following each increase of area, and minimal cell size was considered attained when one or more successive increments failed to yield changes in mean area per individual of more than five per cent. It became clear that chance and the degree of variation within the population of determinants

being sampled both played important roles and that changes of less than five per cent total mean area per individual could possibly occur in increments at any distance from the center. In practice, recourse was taken in watching for a leveling out in the trend and frequent reference was made to the guidelines on prediction of minimum cell diameters as reported by Mills and the Marshall University Group (1963). Both procedures in general were found helpful, but neither was infallible. Sometimes the variability was such that with the increments being used "the trend" fluctuated more than five per cent. Often in mature pine stands too few individuals (usually only one to six) appeared in the first five meter radius area to yield high predictive value, and in the oaks the frequent tendency toward clustering made the precise positioning of the first increment all-important and predictions were usually much too high or much too low.

Eventually, however, having estimated minimal cell size, a plane table was set up and maps showing position and size of the determinant structural types within the sample were drawn. (Minimal cell size was accepted as sample size.) Concurrently non-determinant structural elements were identified, their cover estimated, and for the taller height classes, their numbers tallied. High visibility spray paint was used to mark individual stems as the procedure of measuring and counting progressed.

The total field crew included six individuals who worked on a sample either as a single group of three or more, or on separate samples as two groups of three. At least three men are needed per crew in order to facilitate the work of recording, sighting and measuring; when crown maps are drawn, more than three can work together expeditiously. In samples having either large diameters or dense shade, the range finder at hand was, respectively, pressed to its limit of accuracy or there was insufficient light to use it. Large samples in pine woodlands especially necessitated much tape carrying and handling.

Plane table maps were constructed for nearly all samples having determinants in height classes five, six, or seven. None were attempted for samples of low or really dense vegetation such as that of old fields or thicket.

5. Mapping

A vegetation map has been developed and is presented separately as Plate No. 7.

In its construction four sets of aerial photographs have been used as a principal source of information. All of the photos were at scale of 1:20,000 and overlap within each set was good. Between the sets there was very little duplication. Santa Rosa Island appeared in two sets as the southern end points on several north-south flight lines and again as the principa' subject on an east-to-west flight beginning

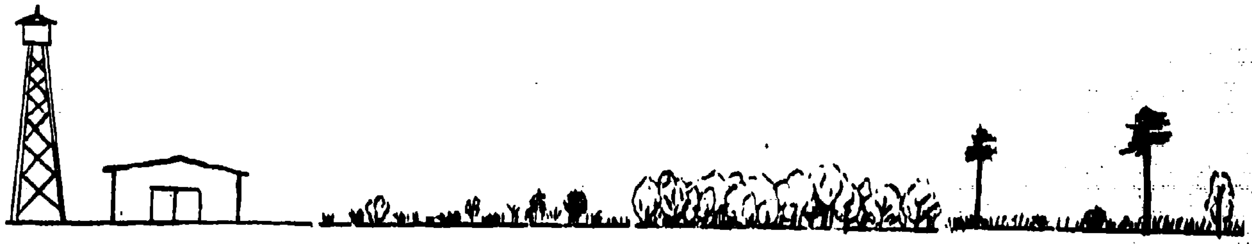
at range 21. The set covering the western two-thirds of the area was dated January 1949 and that for the adjacent next largest area was dated March 1955. The other small sets were dated January 1958 and March 1961 respectively. In all of the photos leaves were present on many of the broadleaved plants reflecting the presence of numerous individuals of broadleaf evergreen species, the persistence of dead leaves on scrub oak species in midwinter, and the fact that spring arrives early to inhabitants of the gulf coastal plain.

The vexing major problem was to extrapolate from the detail of limited numbers of ground samples to the relatively large scale of the photographs. Height and density of cover, and in numerous cases density of stems could be estimated at least for the taller height classes. Variations in each of these three factors singly, or together in combination, could result in much variety and are, in fact, the bases of difference among more gross categories of vegetation types commonly recognised by geographers. When major classes of these variations are considered in combination with possible kinds of military activities and then these categories rated against the chances that they can be detected with dependable accuracy from large scale photos the number of categories that emerges is relatively small. Chance of success in a larger range of classes is likely to be heightened if the interpreter is familiar with the vegetation to be mapped, but it seems clear that the

least informed interpreter will have a better chance for accuracy if the list of classes is kept brief. In the present instance the chief photo interpreter was also a member of the field party.

Mapping units recognized in the Eglin area are depicted in Figures 27 and 28. They are in general similar to those recognized at Dahlonega but there are several modifications. Included are two new categories, Graminoid and Steppe, the additon of which makes the system of much wider application (well beyond the mountain forests). Under the grass category are the tall grasses of the dunes of Santa Rosa Island, but more importantly from an areal standpoint, the boggy meadows of the mainland with their occasional clumps of shrubs and the wet marshes of the coastal points and river mouth shallows. The steppe category is needed for the sparse, low, often broad-leaved vegetation of the dry or wet sands of the interdunal areas of the Island. Slash as a category has been left off the Eglin list, inasmuch as the Air Base Forestry Division is managing their harvests in phenomenally clean fashion. The unit headed culture (Dahlonega report) has been converted to a unit having the title "Barren," to include mappable sized areas where there are no (?) plants. These would include beaches, large buildings, airstrips, and soil patches that are free of plants perhaps because of traffic concentrations. Farmland and grounds in meadow are here considered graminoid as to type.

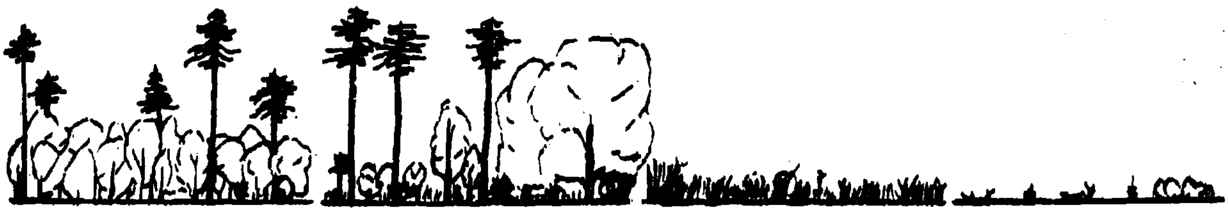
Barren	Old Fields	Thicket	Savanna-Woodland
	Cover extremely variable - lacking in upper ht. classes; may be complete in one or more classes 1-4.	Up to 100% closure in each ht. class 3-6; stem density high.	Up to 50% cover in ht. classes 5-7; up to 100% cover in ht. classes 1-3; stems widely spaced.



Barren	Old Fields	Thicket	Savanna-Woodland
Buildings, airstrips, bare soil, beaches.	Weedy mixture of low and often rough herbs, decumbents, and seedling trees; sawbriers and poison ivy are common.	Dense mixture of small stemmed small trees, robust shrubs; low and profuse branching.	Two-layered; scattered tall trees, a few low shrubs; nearly continuous ground cover, often graminoid.
No cover; zero to unimpeded passage; people, vehicles, dogs common; visibility variable.	Poor to no cover; often tangled under-footage; variable visibility.	Good cover; slow and difficult foot passage; soft, often wet substrate; visibility poor to nil.	Poor cover; nearly unimpeded passage by foot or transport; visibility good.

Figure 27. Mapping Units (Eglin Area)

Forest with Thicket	Forest - No Thicket	Graminoid	Steppe
50-100% closed overstory in ht. classes 5-7; 30-100% cover in each ht. class 3-5; large and small stems abundant.	50-100% closed overstory by trees in ht. classes 5-6, sometimes 5-7; stems tend toward even spacing.	Up to 100% cover each ht. class 1-4 by grasses, grass-like herbs.	Up to 10% cover each ht. class 1-3; stems mostly herbaceous.



Forest with Thicket	Forest - No Thicket	Graminoid	Steppe
Two layered; moderate to dense stand of tall trees (pine) emergent above a dense stemmed thicket, typical of low ground subject to frequent flooding.	Mixture of tree sizes; good overstory, variable epiphytes, shrubs and herbs below; includes cypress-gum type of flooded lowlands.	Elaborate ground story of grasses, sedges and herbs; meadows, marshes sometimes with occasional low shrubs.	Sparse partial ground layer of low grasses and rough herbs.
Excellent cover; tedious foot passage any time; transport passage unlikely - especially in wet weather. Visibility very poor.	Excellent cover; easy foot passage on uplands but water a hazard on lowland; visibility variable.	Variable cover; passage variable often dependent on site and weather; visibility variable to excellent.	No cover; impedence by vegetation nearly lacking; visibility unlimited.

Figure 28. Mapping Units (Eglin Area)

Perhaps the most debatable boundaries between the categories are those dealing with the forest and "near-forest" societal organizations. As compared with broad-leaved species, pines tend to have small diameter crowns and stands having good forest stem density and other characteristics may have very much less than a closed overstory. At the other end of the range are the savanna types having low stem density and therefore also very low crown cover. Between these extremes are many intergrades - relatively open stands of pine having grassy, savanna-like ground cover but much more than the 25 per cent cover in the top story suggested for upper limit of savanna by Dansereau (1958, 1960). These would perhaps more accurately be designated woodland, but both the lower and upper borderlines would result from arbitrary decision despite their own dissimilarities. As a practical (and arbitrary) measure, we have lumped savanna and woodland together and have attempted to draw only one boundary separating savanna-woodland from forest. In doing this we have emphasized the aspect of cover and set the dividing line at 50%. It is not intended that stem density be downrated as a criterion of distinction but cover could be estimated with better accuracy on our photos. Height class five scrub oaks are both numerous and narrow crowned.

Attempts to distinguish four kinds of forest have been made. Among these the discrimination between pine and oak-pine is likely to

be the least reliable; the hammocks and the cypress-gum swamp forests have closer association with topographic features that are easier to rate.

In the construction of the map the photo interpretations were traced directly onto a clear plastic overlay that had a number of reference points previously established from topographic map enlargements to scale of 1:20,000. In this way problems of local scale warping due to flight irregularities were absorbed photo by photo. The overlays were then traced off and the material reduced to scale of 1:50,000.

D. Results

Much of the Ranger Training Area is covered by some kind of evergreen forest, and pine is by far the commonest plant on the horizon.

Eighty-nine samples were obtained by the nested, variable radius, circular plot method, and their locations are shown on a map, Plate 8.

Diameters of plots ranged in size from 1-50 meters with a median for all samples at 25. The smaller sized plots were in generally low or dense vegetation. Of 14 samples with diameter less than ten meters, nine were in grassy areas and three were in thickets. Median plot diameters were 25 meters each for forest and savanna, and their ranges were much alike - beginning at 10 meters and extending to 45 and 50 meters respectively. Somewhat surprisingly the samples from old

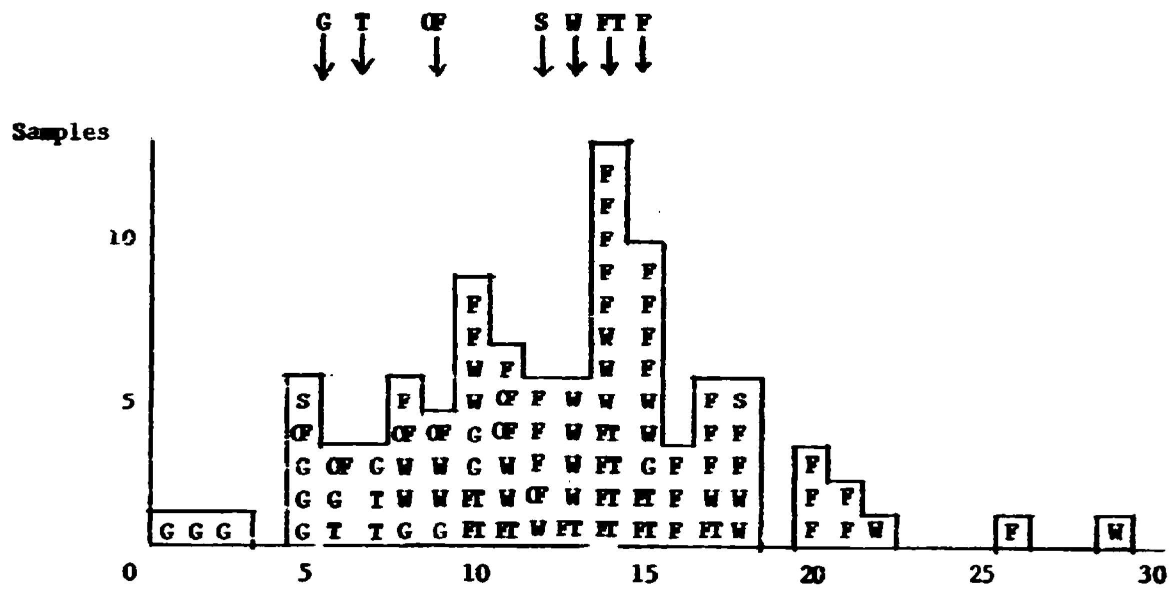
fields have the largest mean diameter; although the vegetation there is generally low, woody perennials and broad-leaved horbs are in low density.

Vegetation diagrams for all samples have been constructed according to the WES life-form system and are submitted as separate sets, together with a copy of the original field tallies.

Figure 29 depicts the variation in numbers of kinds of structural elements appearing in the diagrams of the samples. The range among all samples is 1-29, and the median sample has 13.

The same figure also presents a comparative measure of the variation in complexity of the different units employed as mapping types. Least complex is the graminoid vegetation, which has only one sample exceeding the group median in number of elements. Thicket appears next and resembles graminoid but offers data from only a very few samples. Despite small numbers of samples, it might well be expected however that any community having cover distributed in a limited number of height classes would also have smaller numbers of elements present. The numbers present in old field samples support this trend, while those of steppe vegetation (only two samples) do not. Not the least striking things about the figure are the representations that grasses (or grass-like plants) can grow almost as "pure stands," and that some stands of vegetation are not only more but several times more complex than others.

Distribution of the seven vegetation categories heretofore



Structural elements

G - Graminoid
T - Thicket
OF - Old Field
W - Woodland
FT - Forest with thicket
F - Forest
S - Steppe

Figure 29. Variation in numbers of structural elements per sample in differing vegetation types. Position of median is shown above.

mentioned together with land that is barren of plants is shown for the mainland at a scale of 1:50,000 Plate 7, and for Santa Rosa Island at scale of 1:20,000 on Plate 1. In addition, under the general heading of forest, an attempt has been made to distinguish between kinds of forests where dominants include a simple majority of pine, or oak and pine, or cypress and gum, or the combination of live-oak and willow-oak and evergreen magnolia, which bedecked with spanish moss often occurs on the knolls and is referred to as hammock vegetation. Further, on the Island, distinction is made within the graminoid type as it refers to the meadow-like marshes or to the tall grasses of the dunes. It should be noted that boundary limits are more easily recognised between some types than others and that distinctions have sometimes been arbitrary. It is very likely that much of the area supporting forest (50% minimum cover) at the time of the 1949 aerial photos has been selectively (or more) harvested and some of it would rate no more than our combined savanna-woodland category today.

Diagrams and photographs illustrating the mapping unit categories are shown in Figures 30-37 and 38-43 respectively.

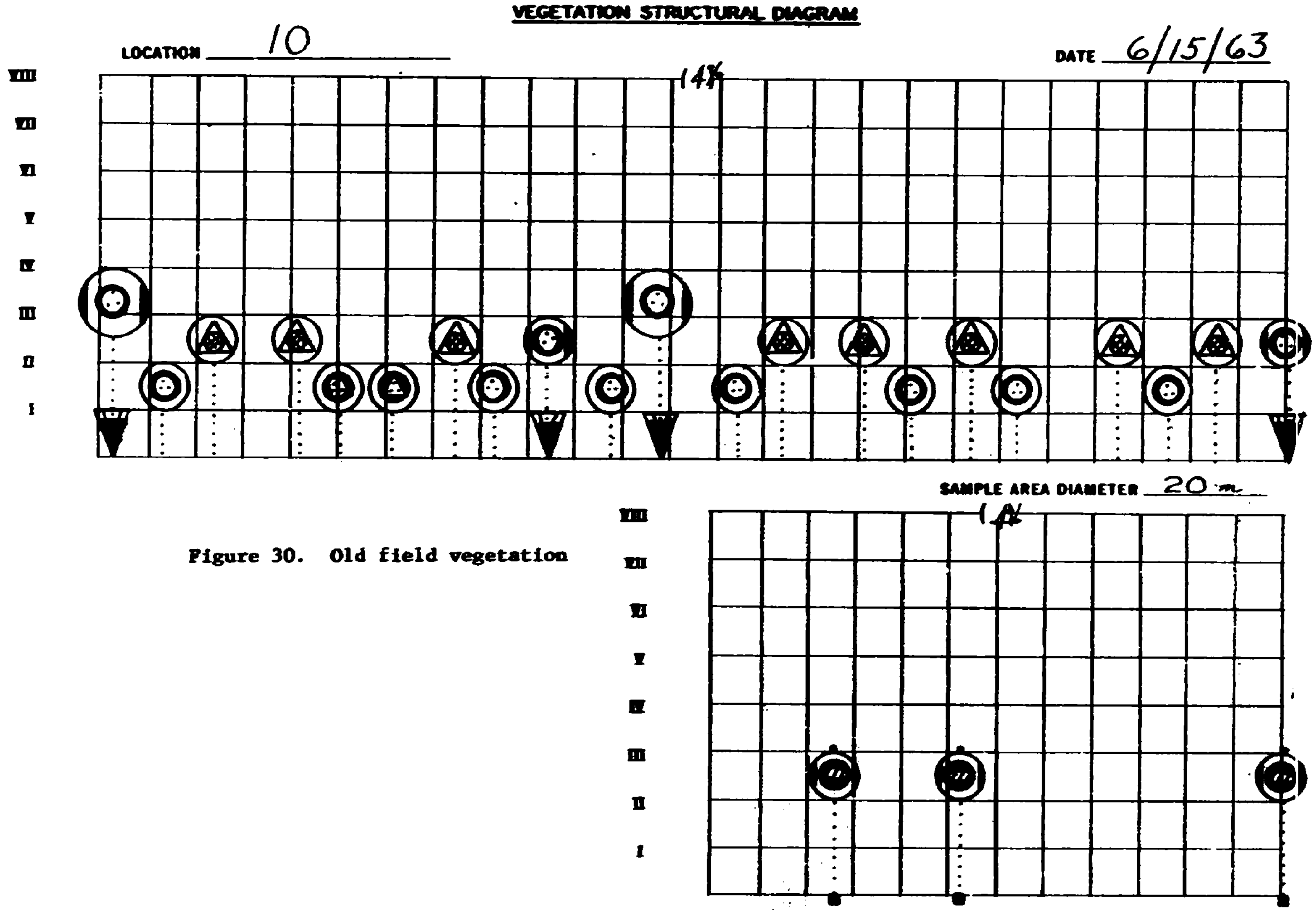
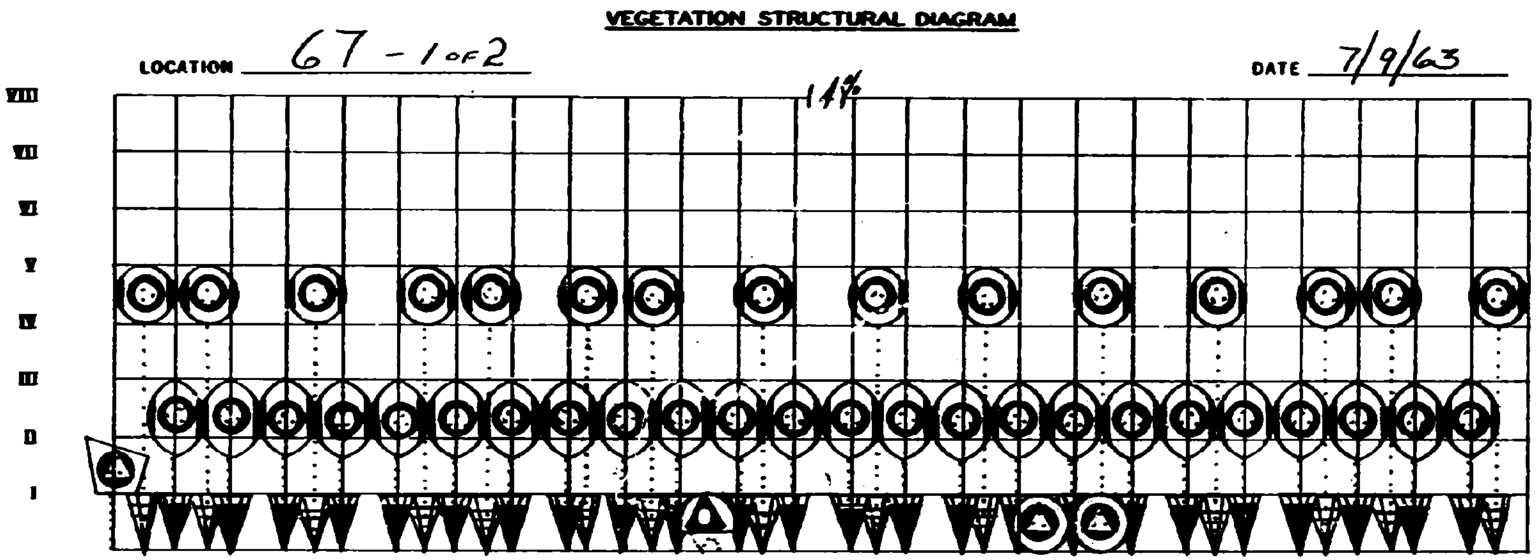


Figure 30. Old field vegetation



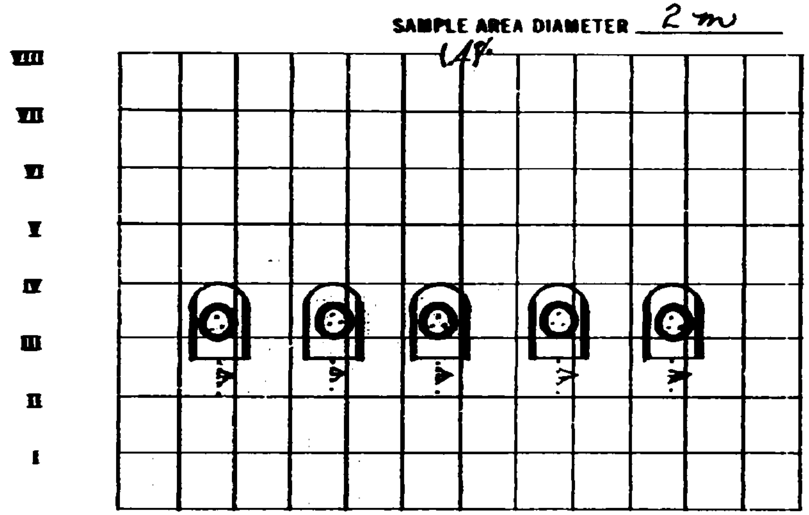
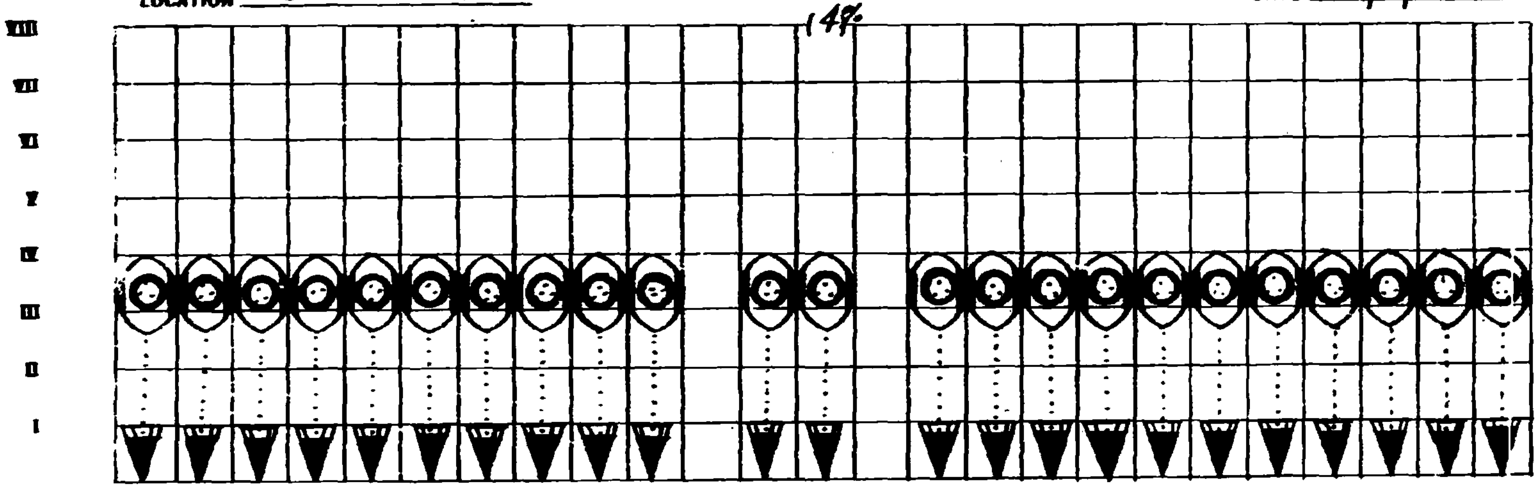


Figure 31. Titi thicket.

VEGETATION STRUCTURAL DIAGRAM

LOCATION 67 - 2 OF 2 DATE 7/9/63



SAMPLE AREA DIAMETER 2 m

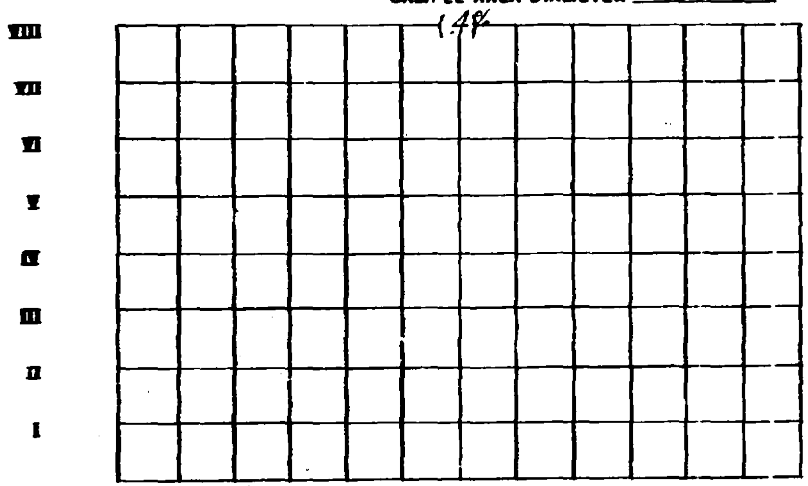


Figure 32 Titi thicket (Continued)

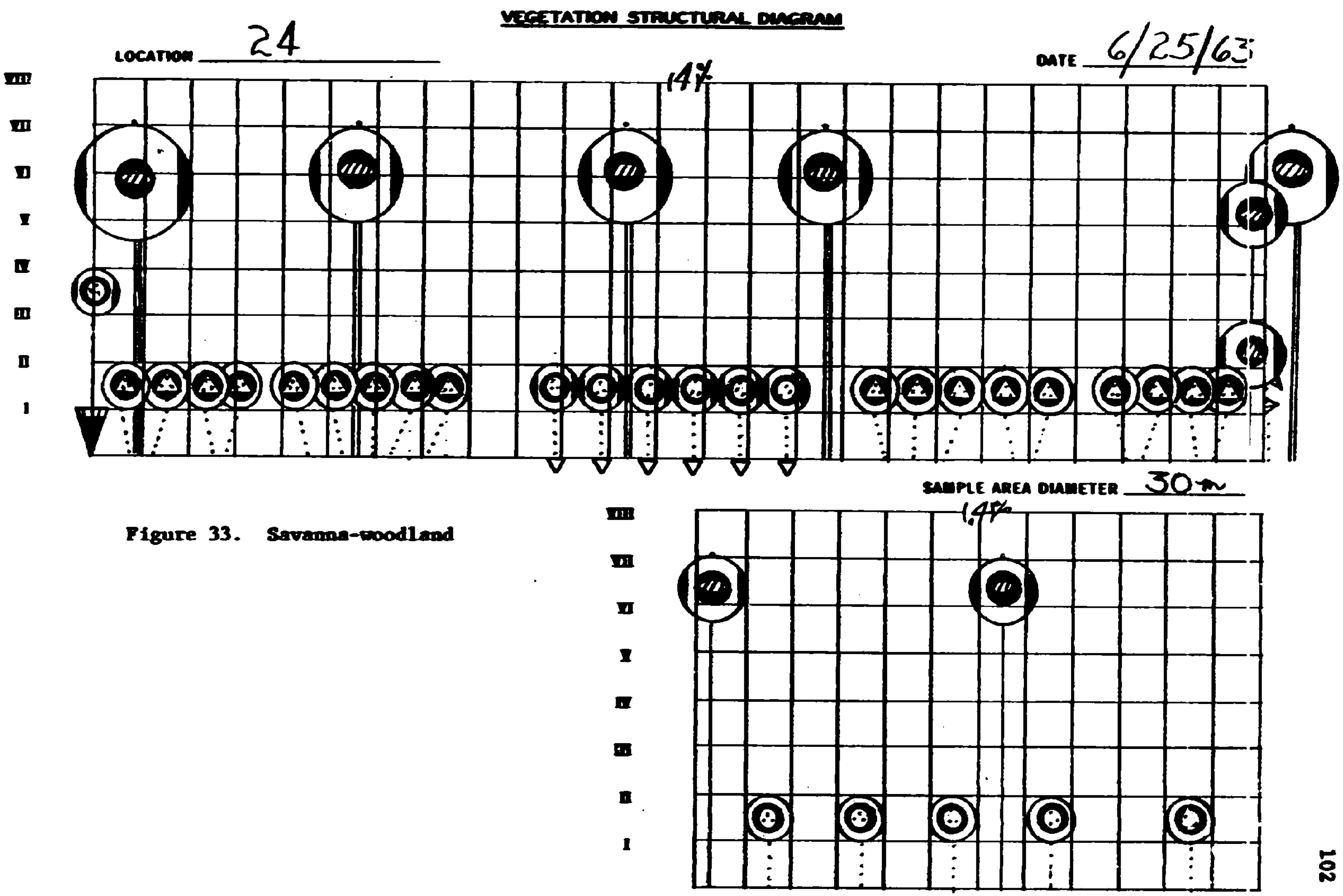
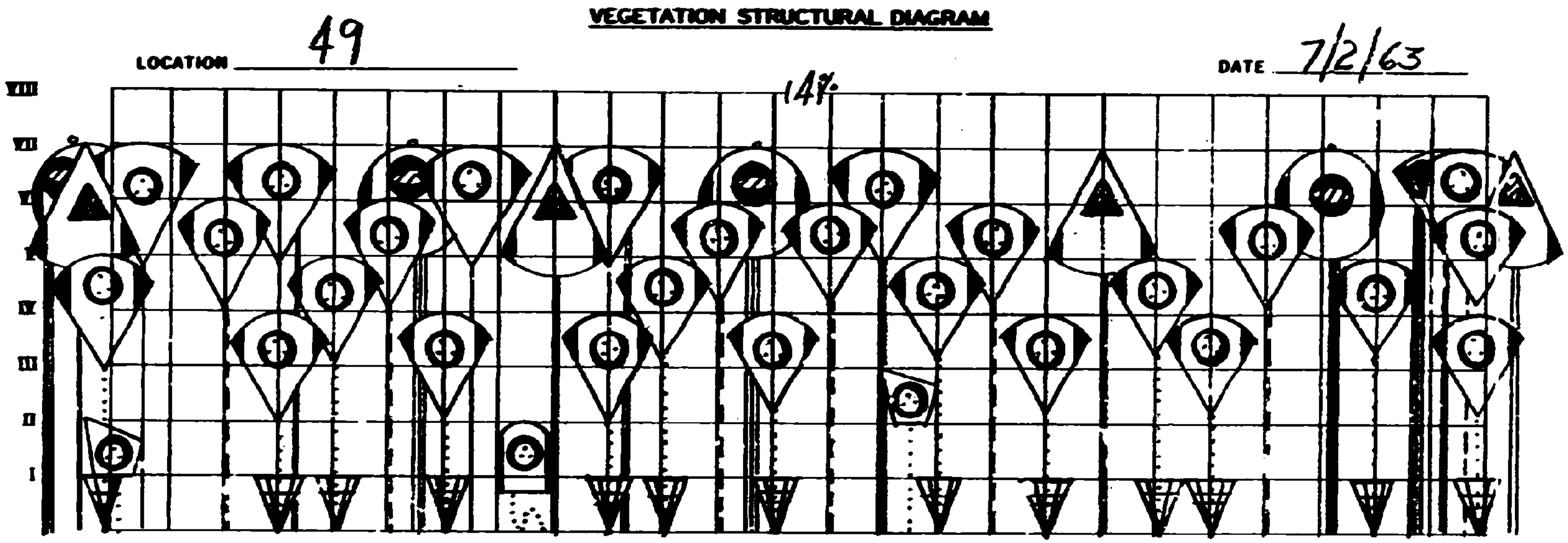


Figure 33. Savanna-woodland



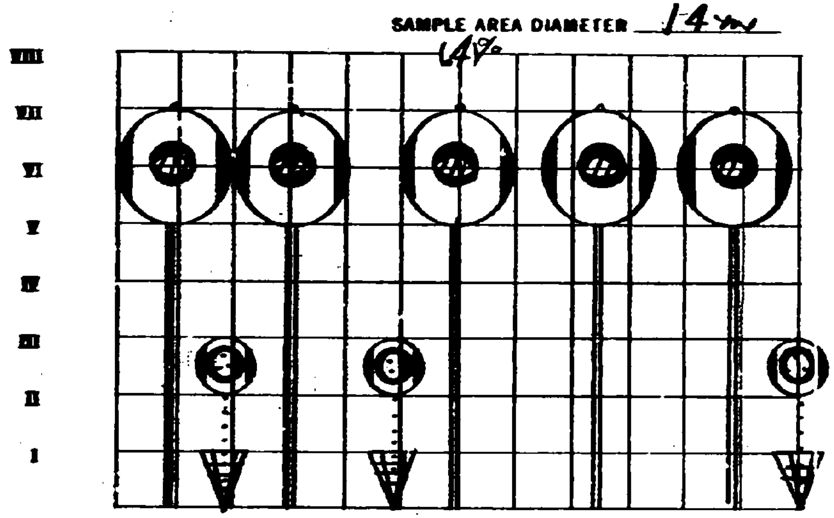
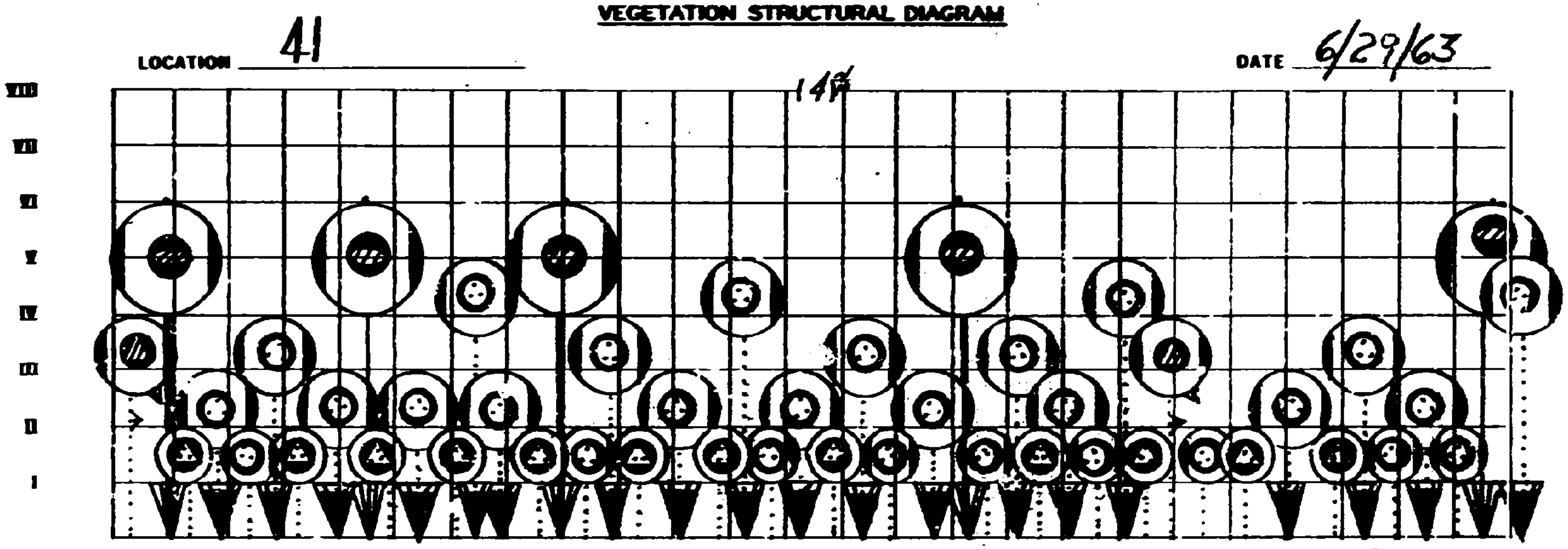


Figure 34. Forest with thicket.



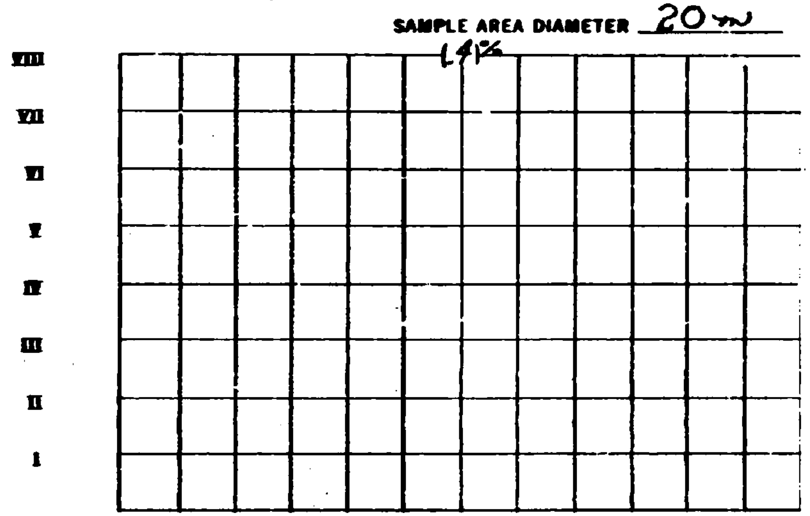


Figure 35. Forest without thicket.

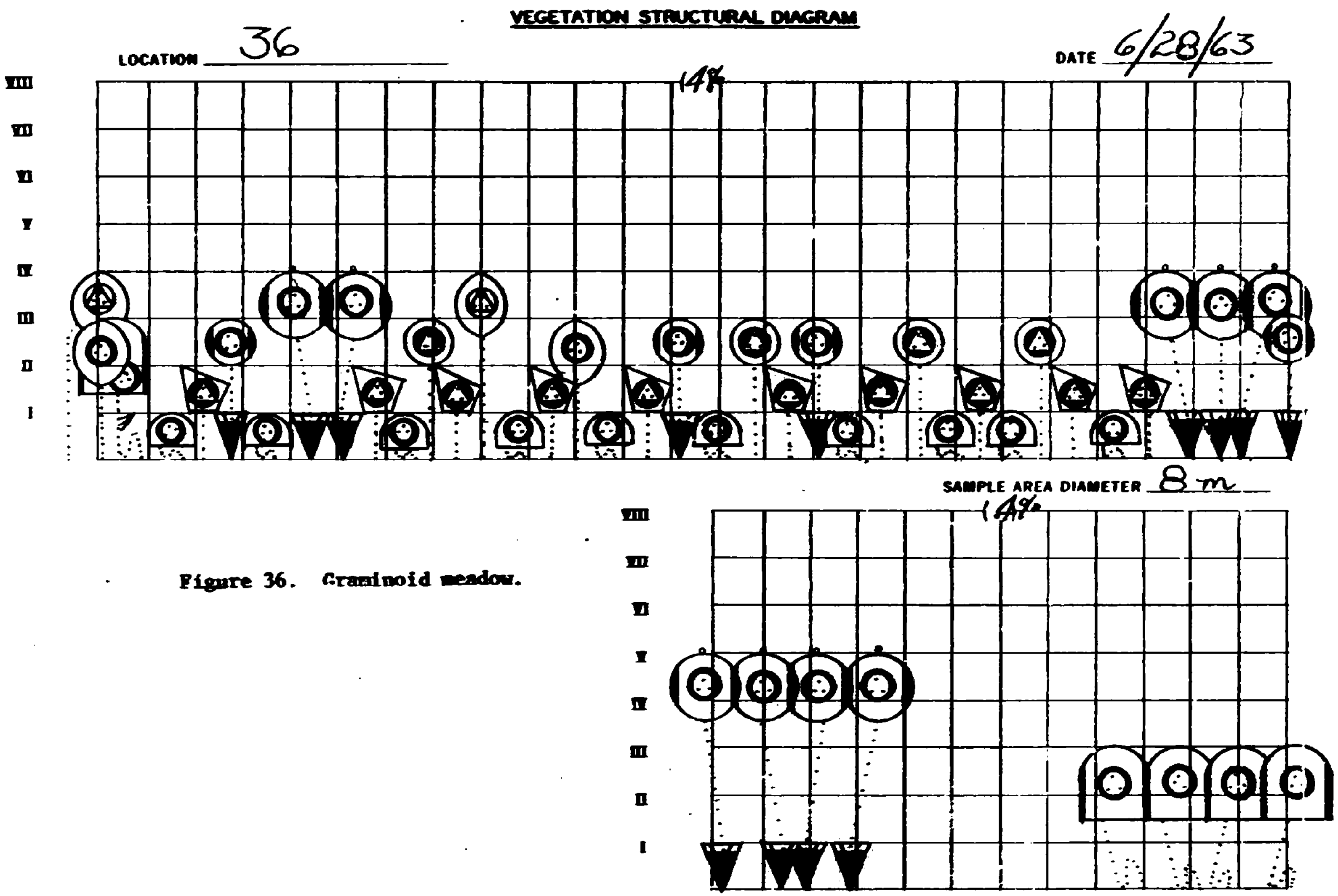
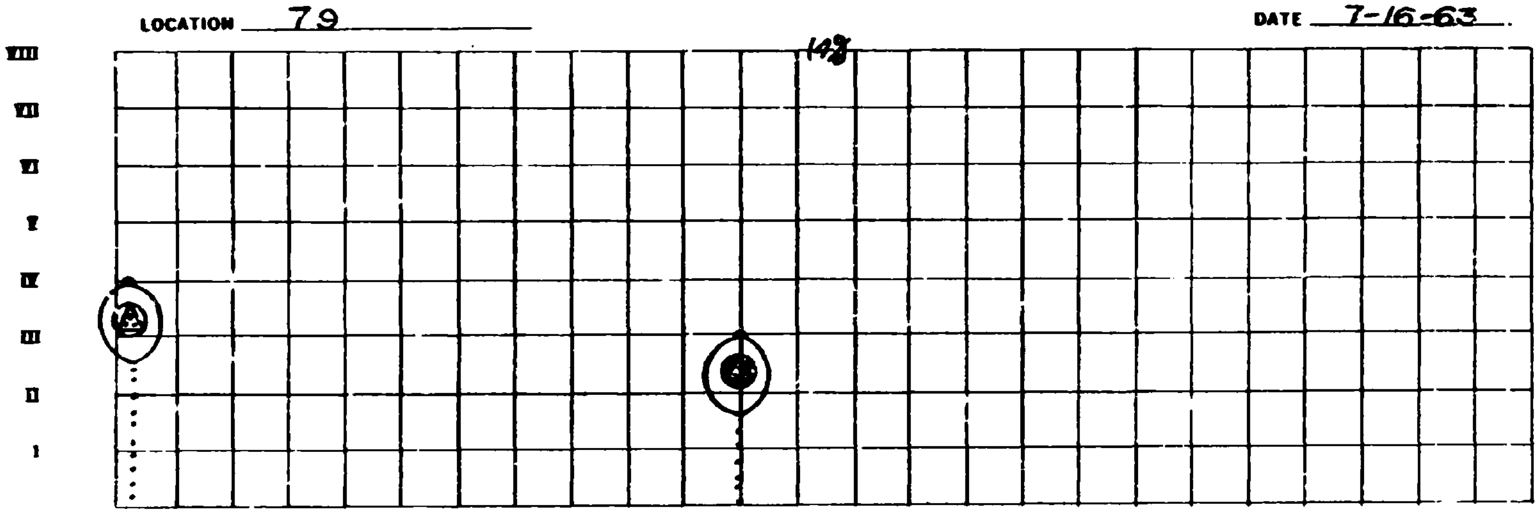


Figure 36. Graminoid meadow.

VEGETATION STRUCTURAL DIAGRAM



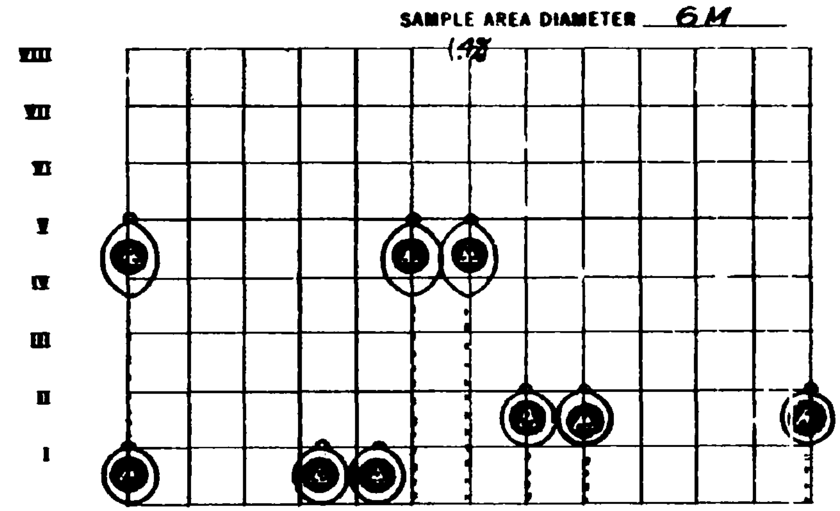


Figure 37. Steppe vegetation on Santa Rosa Island.

Figure 38. Pine forest with characteristic ground cover of palmetto, legumes, and grasses.

Figure 39. Hammock forest type.

Figure 40. Savanna-Woodland vegetation.

Figure 41. Forest with thicket type showing slash pines in overstory and dense titi below.

Figure 42. Graminoid meadow of grasses and sedges.

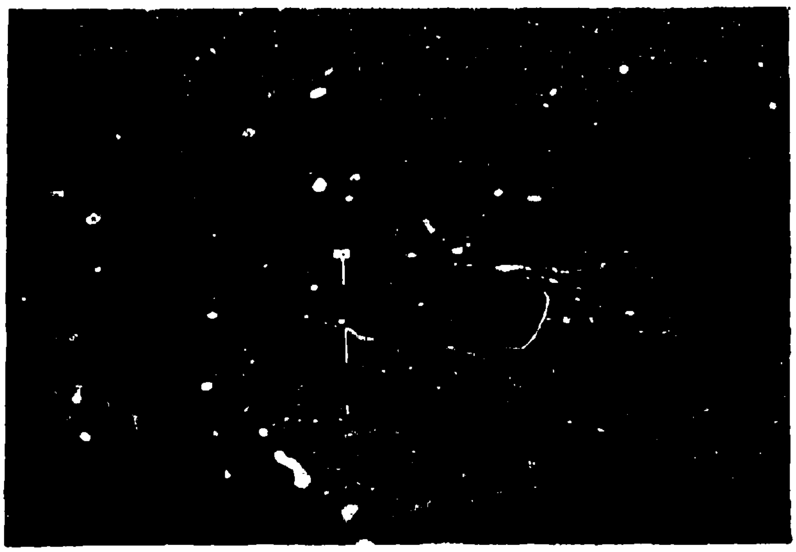


Figure 43. Sparse vegetation on semi stabilized sand areas on Santa Rosa Island. Steppe type.

E. Analysis and Discussion

Average cover by height class is shown for each of the seven mapping types in Figures 44-50, and ranges of the cover are shown in Figures 51-56.

One of the singular features of the vegetation at Eglin Field is the generally low height of the canopy-forming trees. In all of the 89 samples no vegetation in height class eight was recorded. Such complete uniformity could scarcely result from lumbering - ancient or recent, and must be a more direct expression of the relationships existing between the plants and their environment.

Most of the Upland stands in which oaks are co-dominant with pine are two-storied with height classes seven and six pines emergent above height classes six and five oaks, and frequently there are no trees of any kind in height class seven. This is an important factor contributing to the lowness of the average value for cover in Figure 48. Scrub oaks reaching just short of height class six are present in very large numbers and probably the most abundant broadleaf tree in the region is a height class five, crown class two, stem diameter class two oak. Oaks do grow to class seven height but this is principally in the hammocks and is accompanied by a species difference. In habitats more moist than those which typically support the oaks, older specimens of pine regularly reach well up into height class seven.

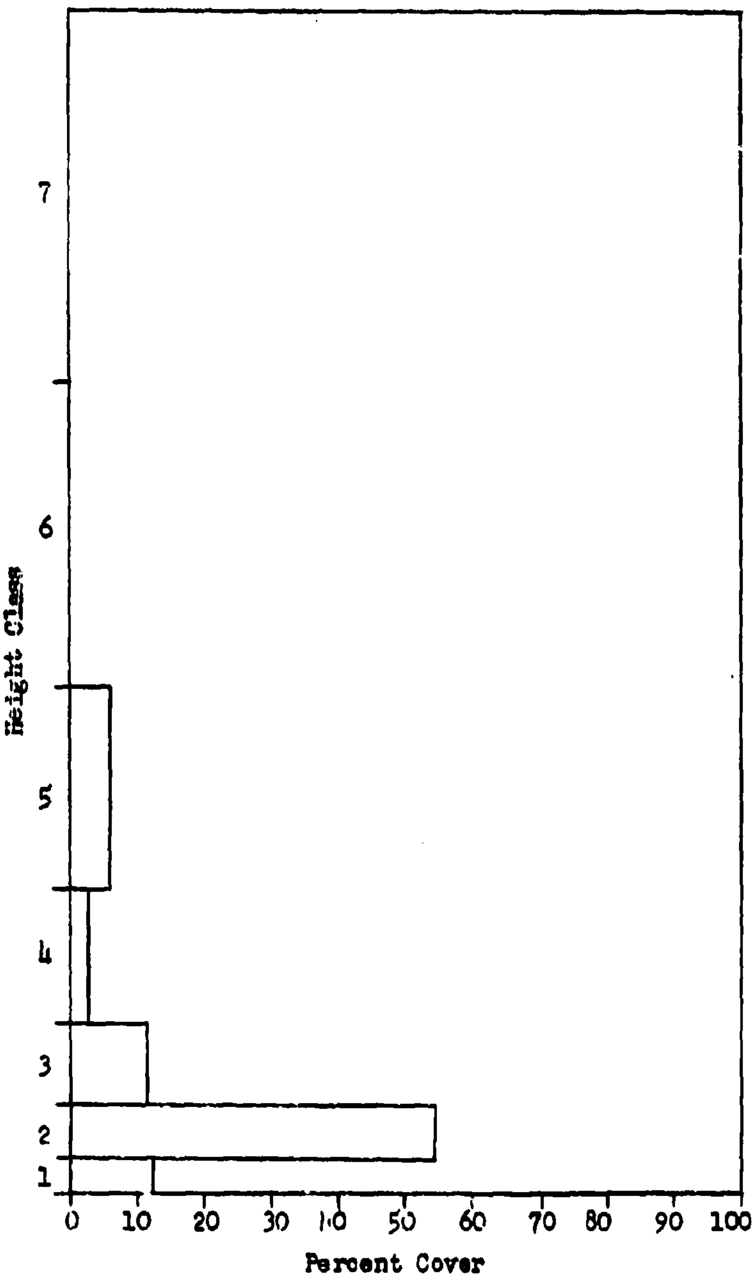


Figure 44. Average cover stratification in seven samples of old field.

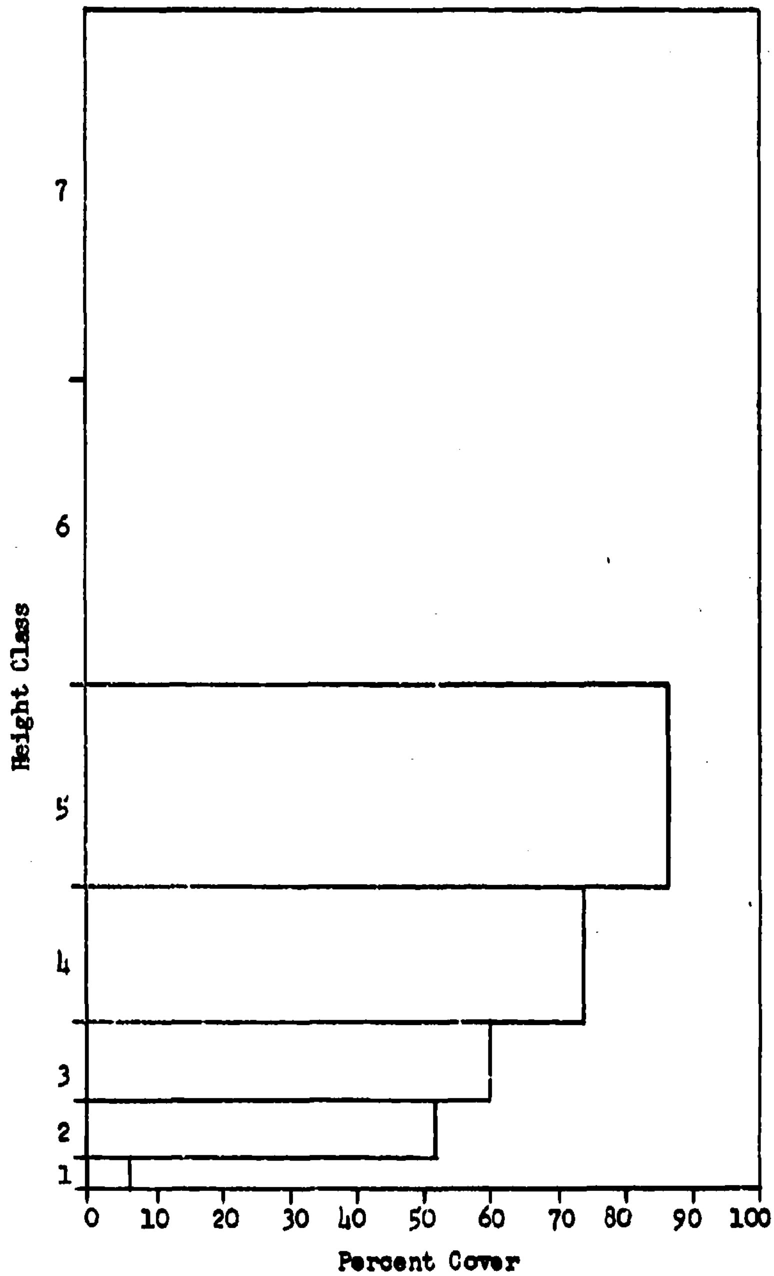


Figure 45. Average cover stratification in three samples of thicket.

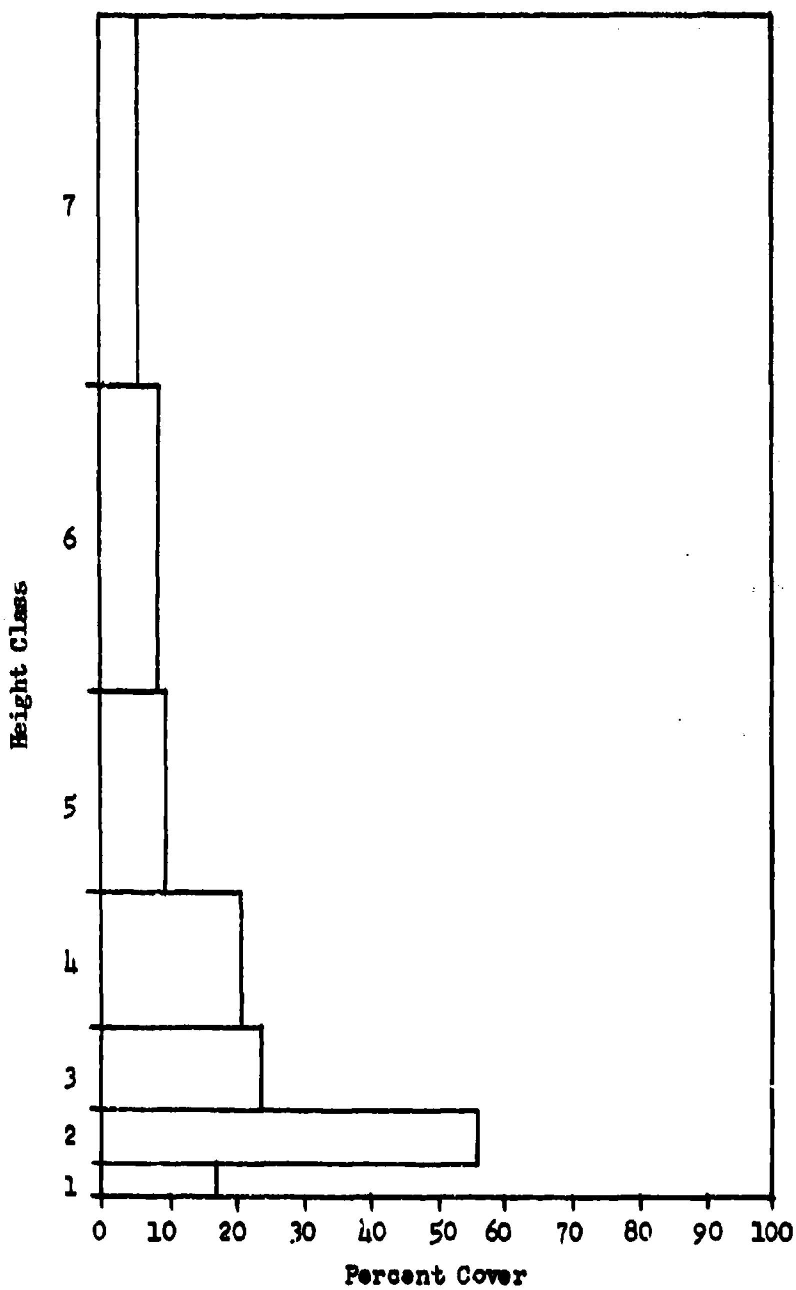


Figure 46. Average cover stratification in twenty-three samples of Savanna - woodland.

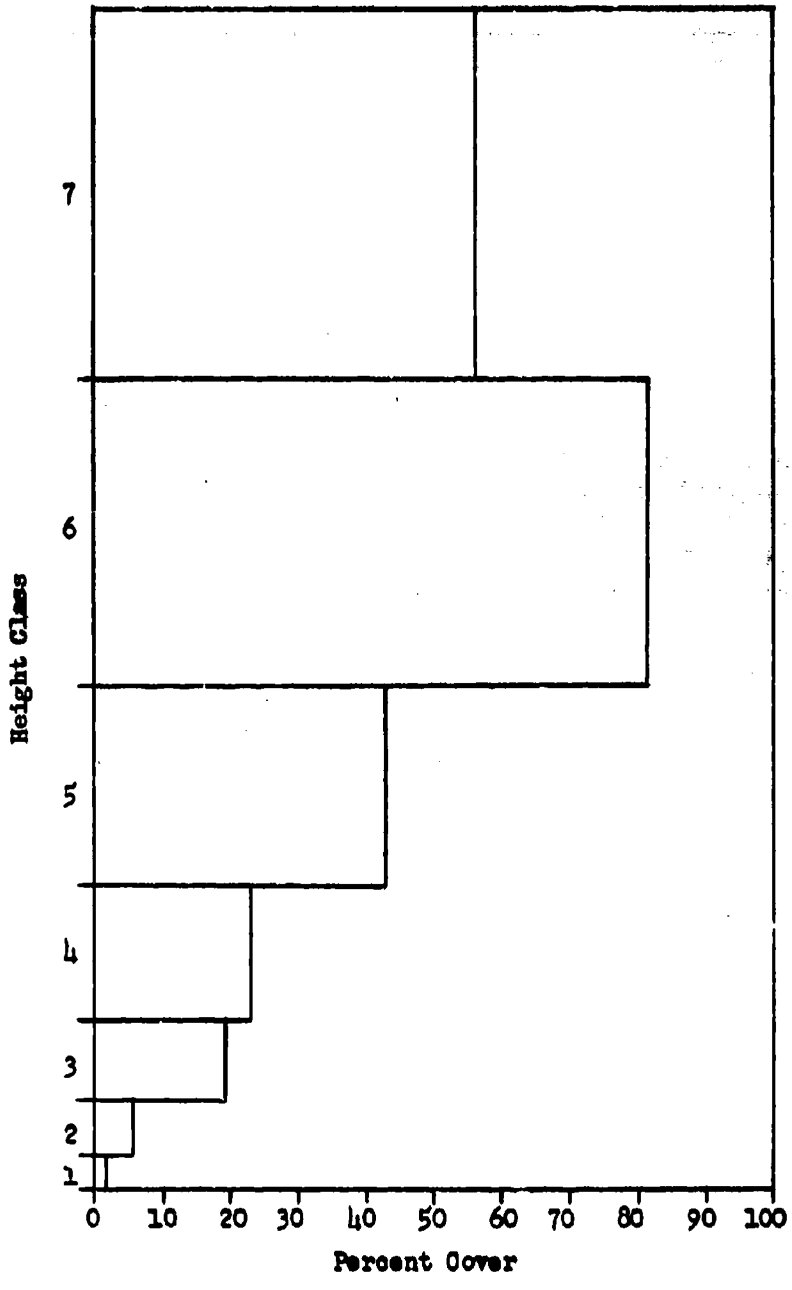


Figure 47. Average cover stratification in eleven samples of forest and thicket.

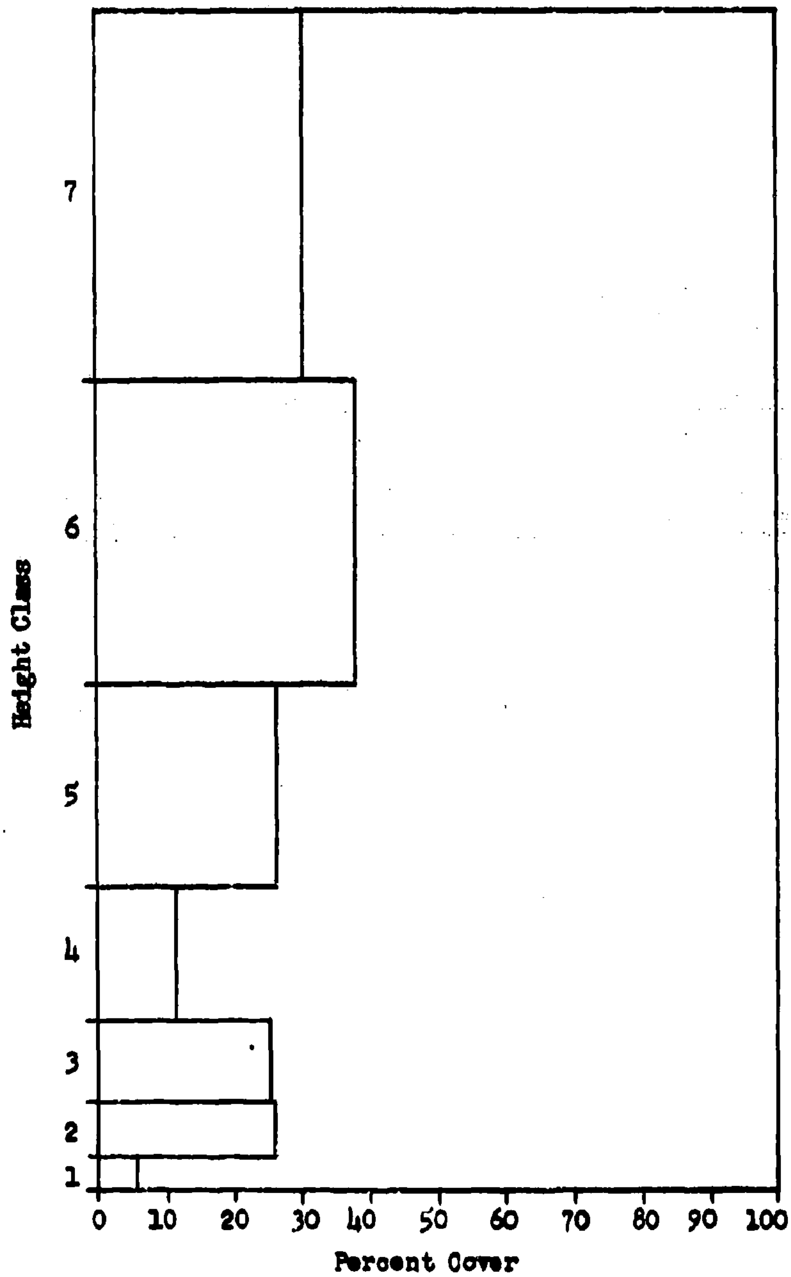


Figure 48. Average cover stratification in thirty samples of forest.

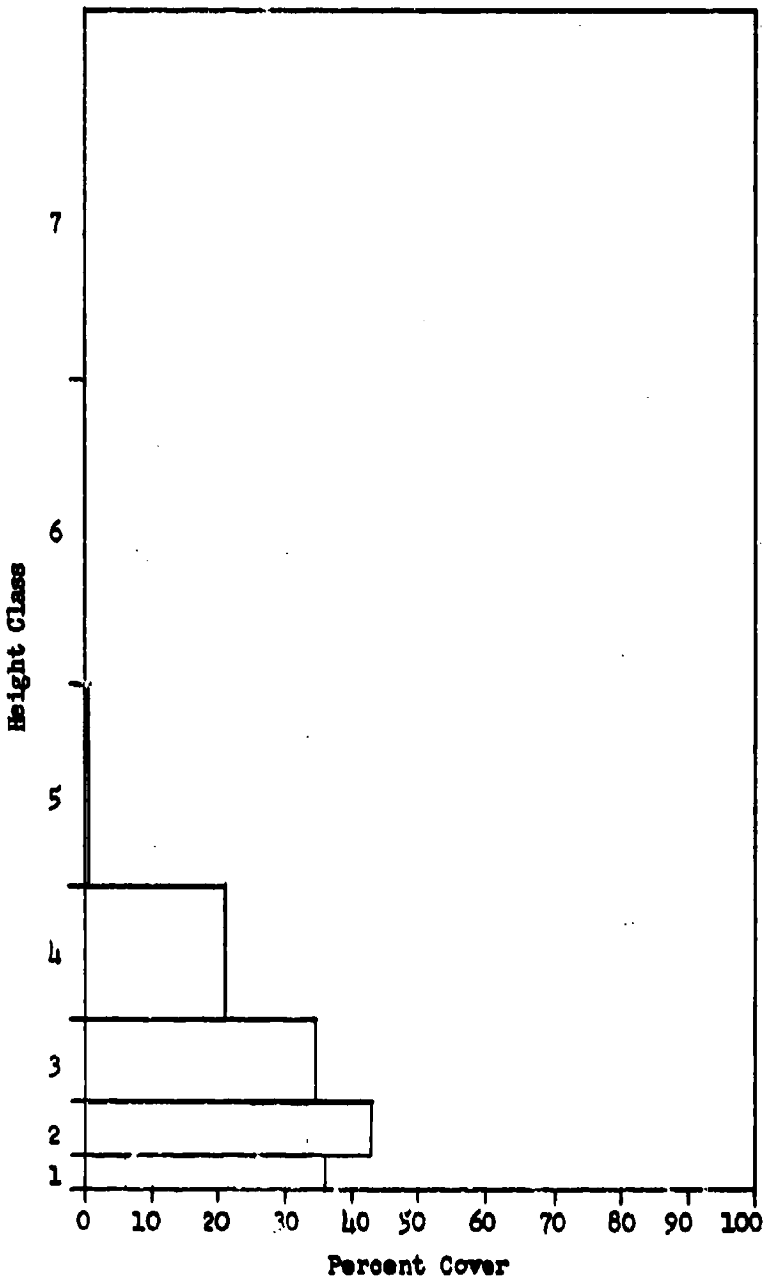


Figure 49. Average cover stratification in thirteen samples of graminoids.

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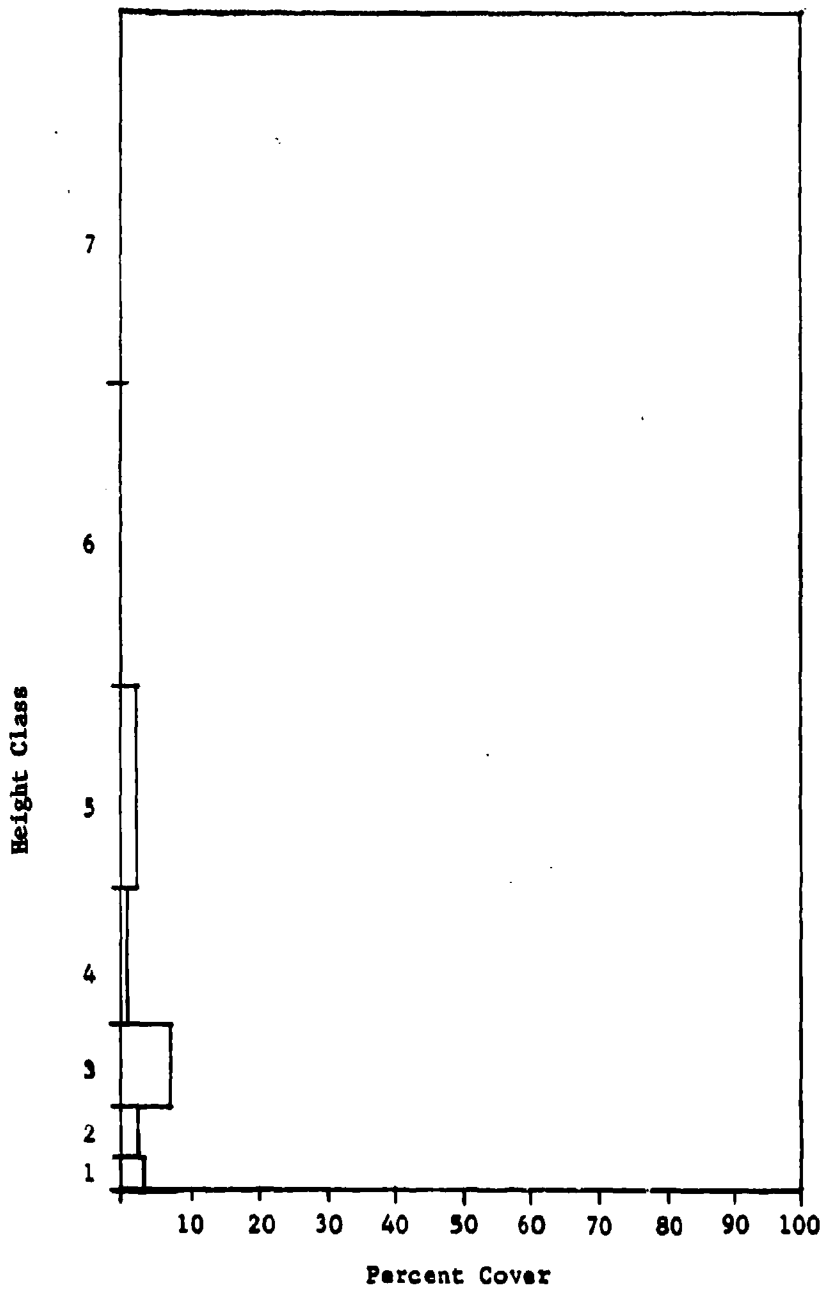

Figure 50. Average cover stratification in two samples of steppe vegetation.

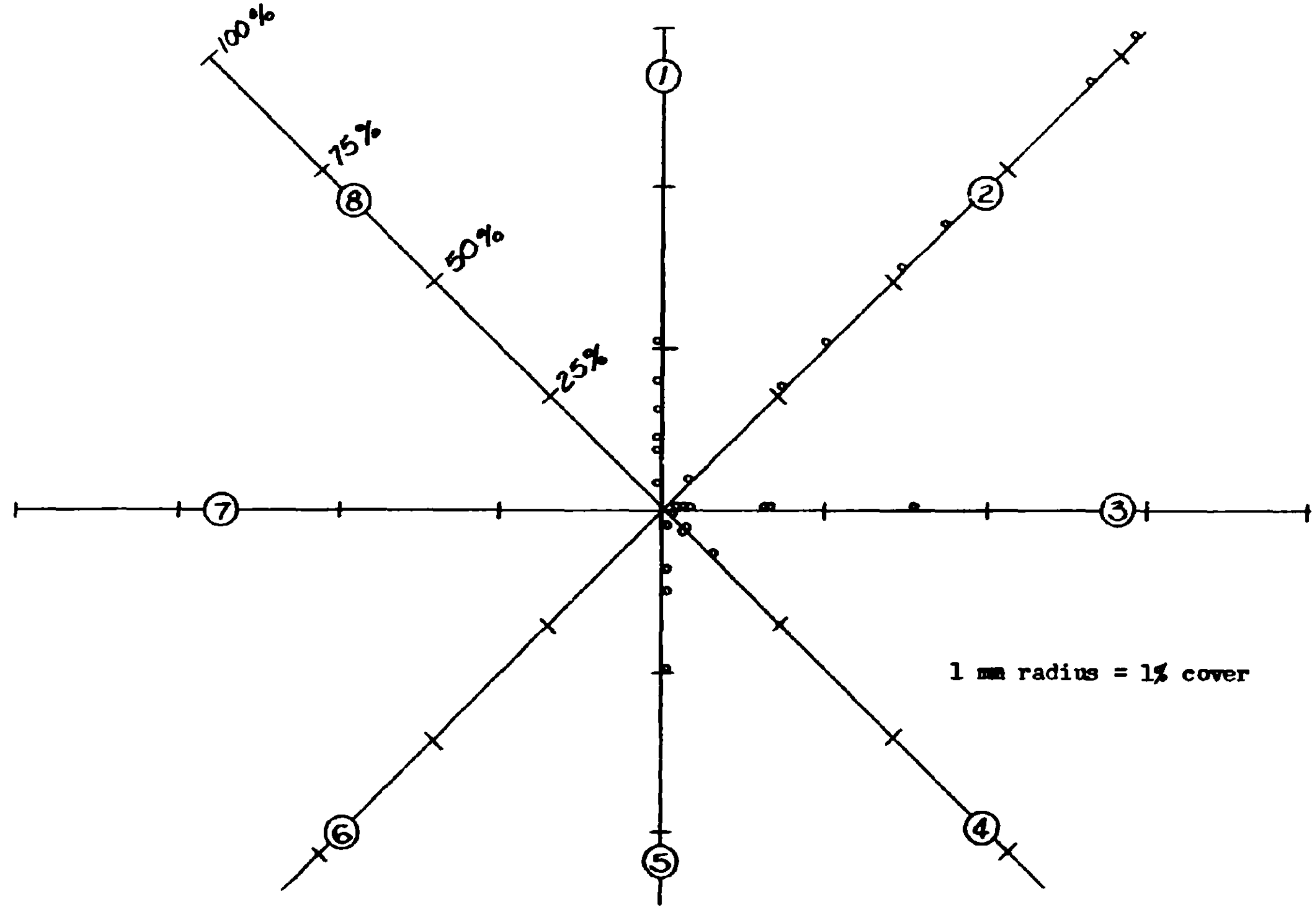

Figure 51. Ranges of cover by height classes in seven samples of old fields.

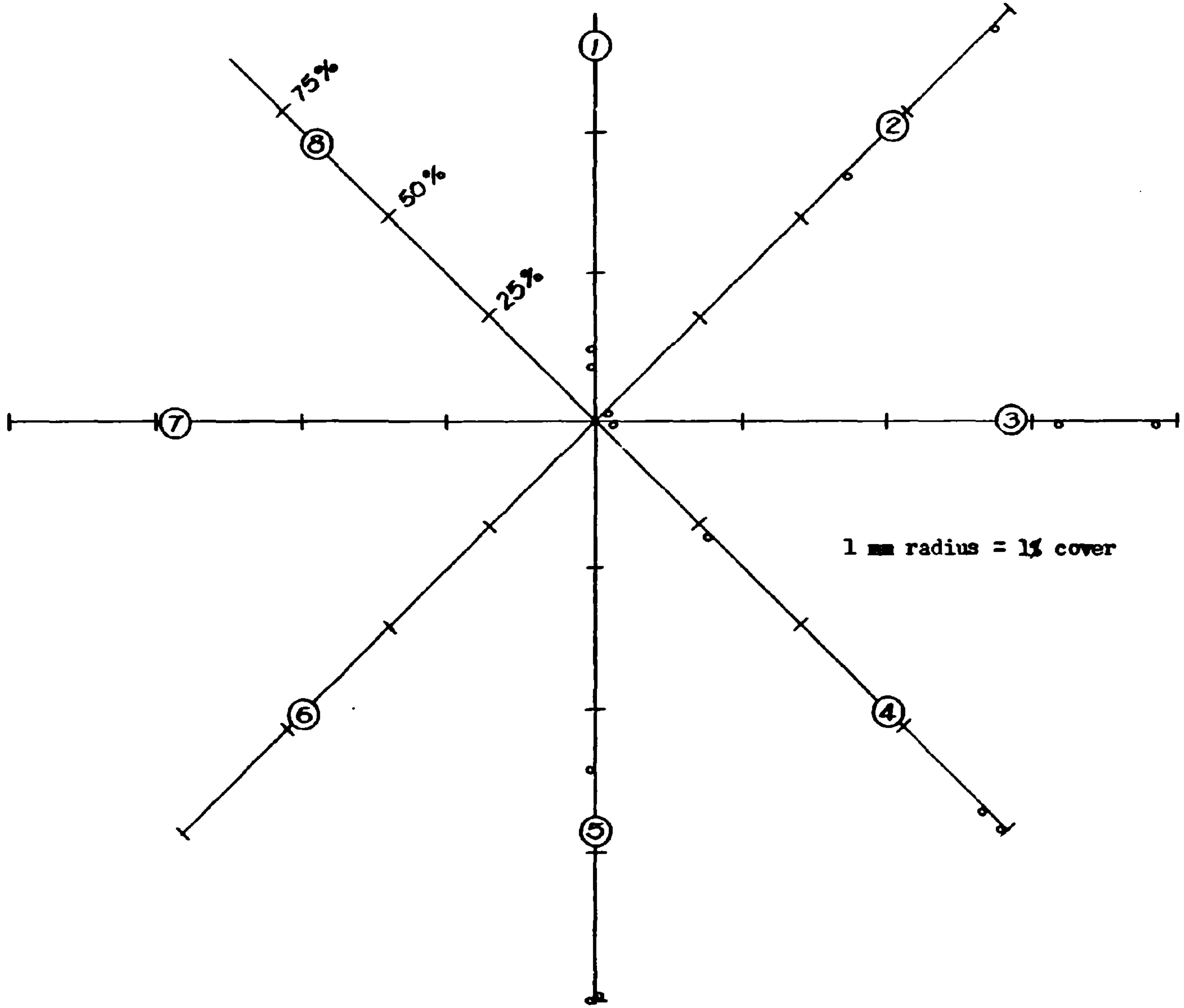

Figure 52. Ranges of cover by height classes in three samples of thicket.

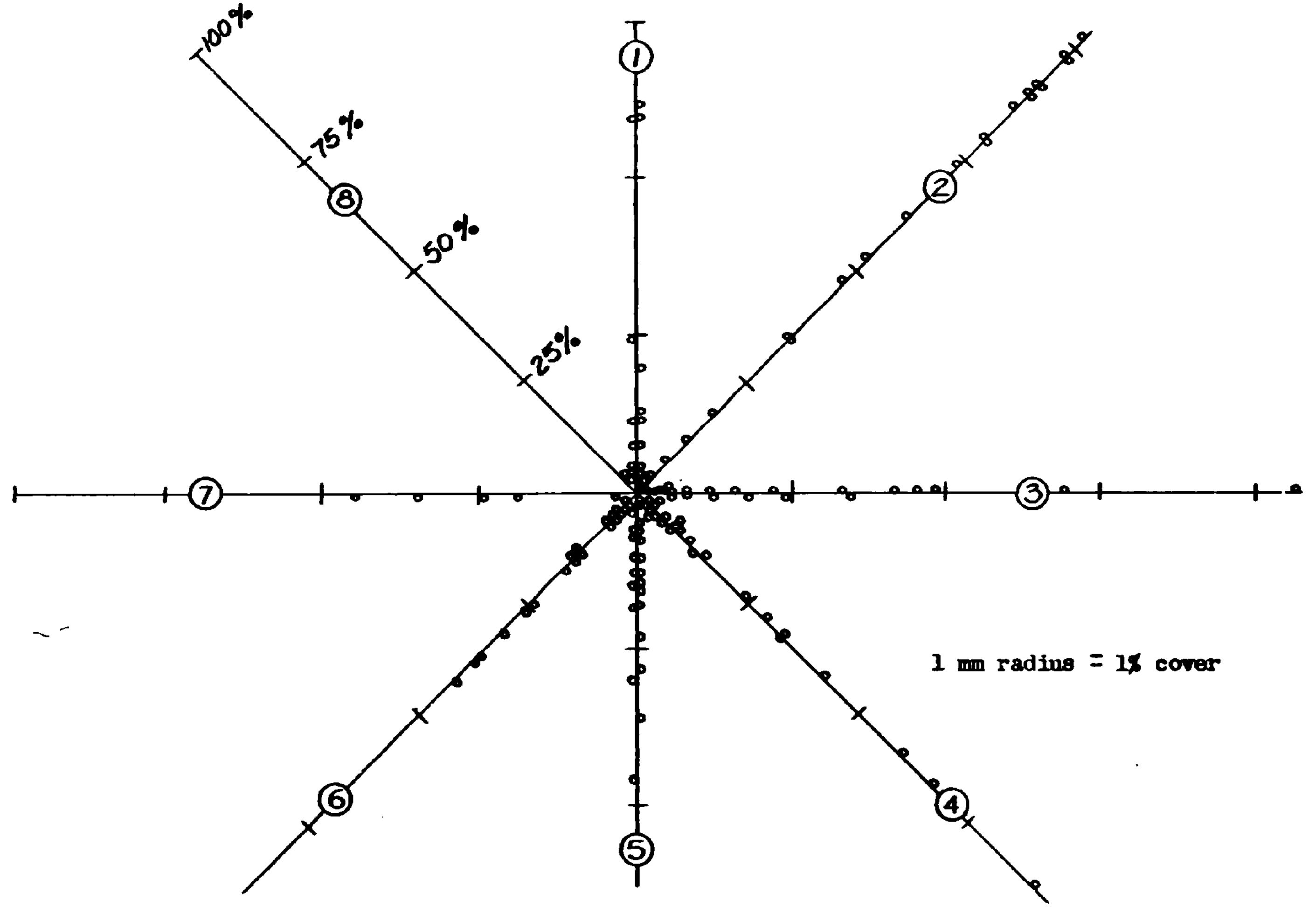

Figure 53. Ranges of cover by height classes in twenty-three samples of Savanna woodland.

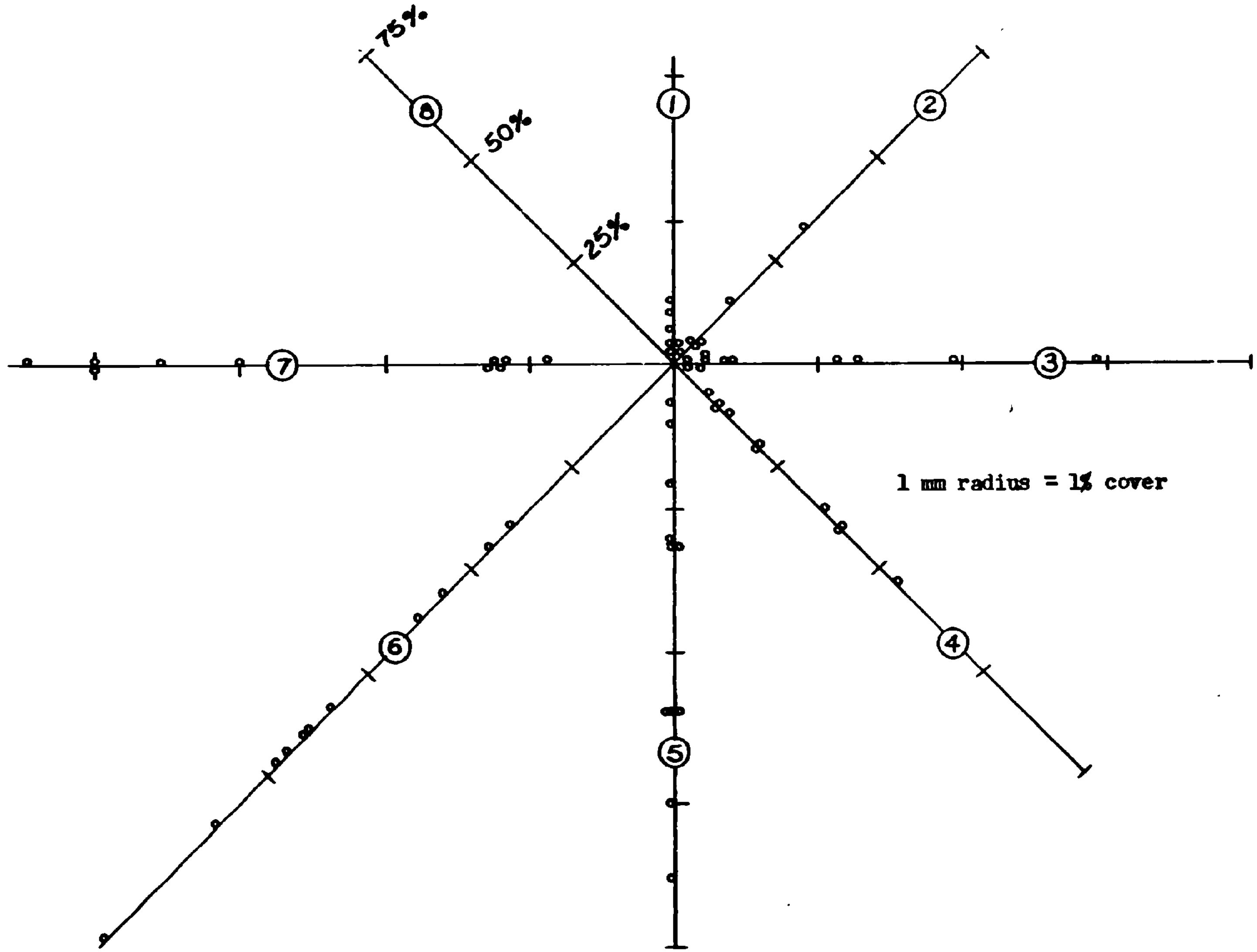

Figure 54. Ranges of cover by height classes in eleven samples of forest and thicket.

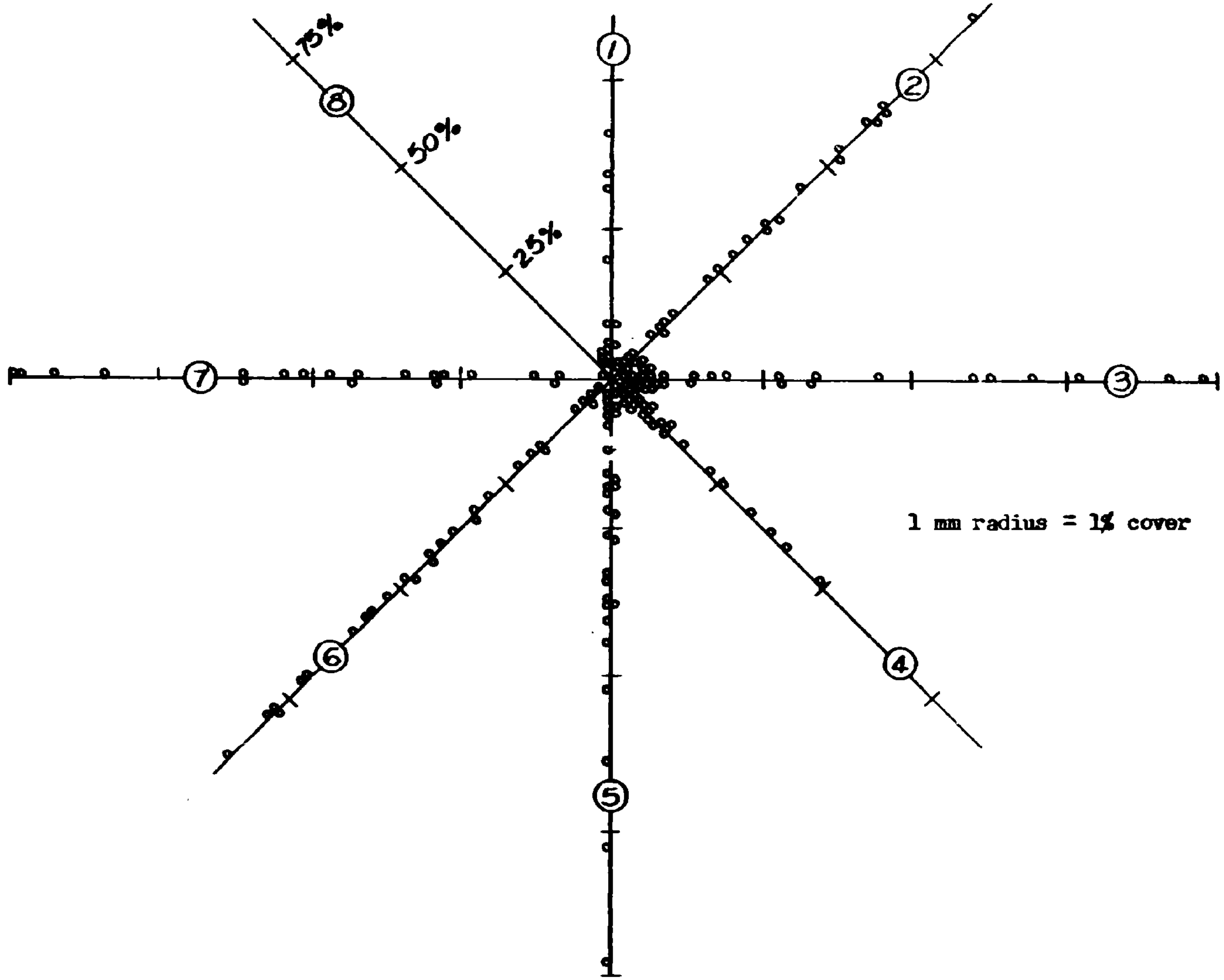

Figure 55. Ranges of cover by height classes in thirty samples of forest.

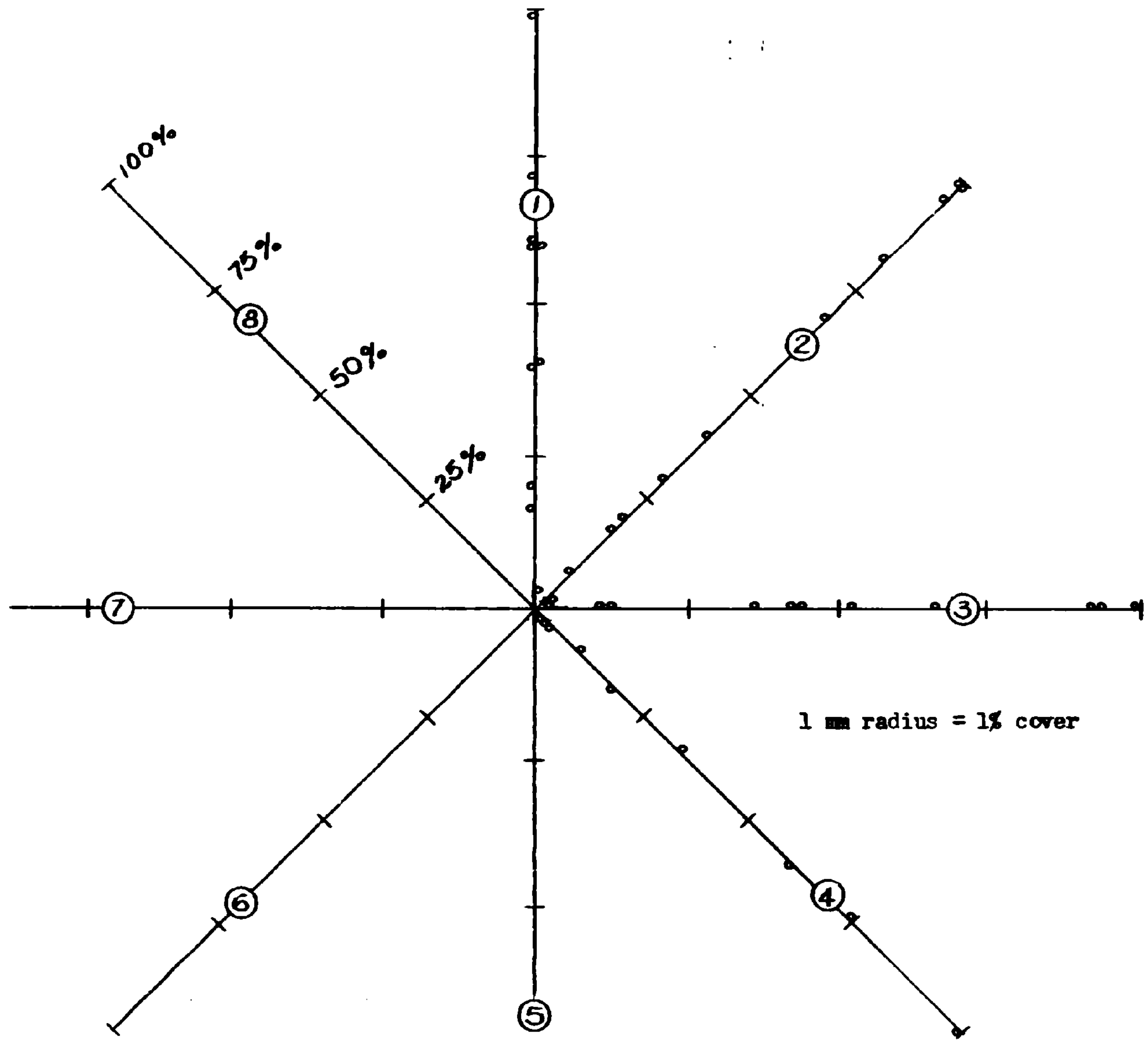

Figure 56. Ranges of cover by height classes in thirteen samples of graminoid.

Forests with thicket are generally composed predominantly of pines emergent over a mixture of small trees and shrubs including sweet bay, tupelo, and titi. This is a wet habitat type of vegetation and occurs abundantly in steepheads and in bottomland areas immediately adjacent to or actually in running water. Typically the overstory extends into height class seven and the type has the most complex (and closed) overstory of any vegetation in the area. It also has the greatest density of stems in diameter class two and above.

It is likely that on Santa Rosa Island many of the mapping boundaries based primarily on the 1958 photographic evidence are by now much out-dated. It is to be expected that in fact only the stabilized dunes are "in the same places." The shore lines as shown on topographic maps and aerial photos of three different ages vary markedly, as do also the precise position of the younger dunes. The Island map presented in Plate I was constructed from the central portions of the 1958 photographs, and therefore will not match precisely any other known map.

Also, with respect to the mapping of steppe type vegetation on the Island, low confidence is expressed with the lower limit of density as steppe adjoins and includes larger and larger patches of bare sand, and with its upper limits as it similarly relates to graminoid type vegetation. Glare from the very white sand also obscures much photographic detail, hence really accurate mapping should only be attempted

on the ground with preferably 100% sampling. Steppe vegetation on the island is highly heterogeneous and undoubtedly contains elements illustrating a great variety of distribution patterns.

Efforts to assess variation in the patterns of distribution of the structural elements used for cell size determination have included lumping of Eglin area data with that from Fort Benning. Discussion of this material is included in the Fort Benning area report.

F. Problems

Among the changes made in 1963 in the system for portraying structural elements was provision for variation of crown sizes within a given height class. A single symbol formerly denoted six, eight, or ten percent cover in accordance with its taller height class, and the numbers of symbols used determined the numbers of stems in the diagram. With the change, more classes of crowns are recorded and there is a closer approximation to actual field conditions in that there are fewer small-crowned plants lumped together without representation of their stems. The change represents an improvement, but stem density in the lower strata is still very far from realistic espression. Figure 57 shows for 105 structural elements from 16 sample plots the percent of stems occurring in the field that later became depicted in the diagrams.

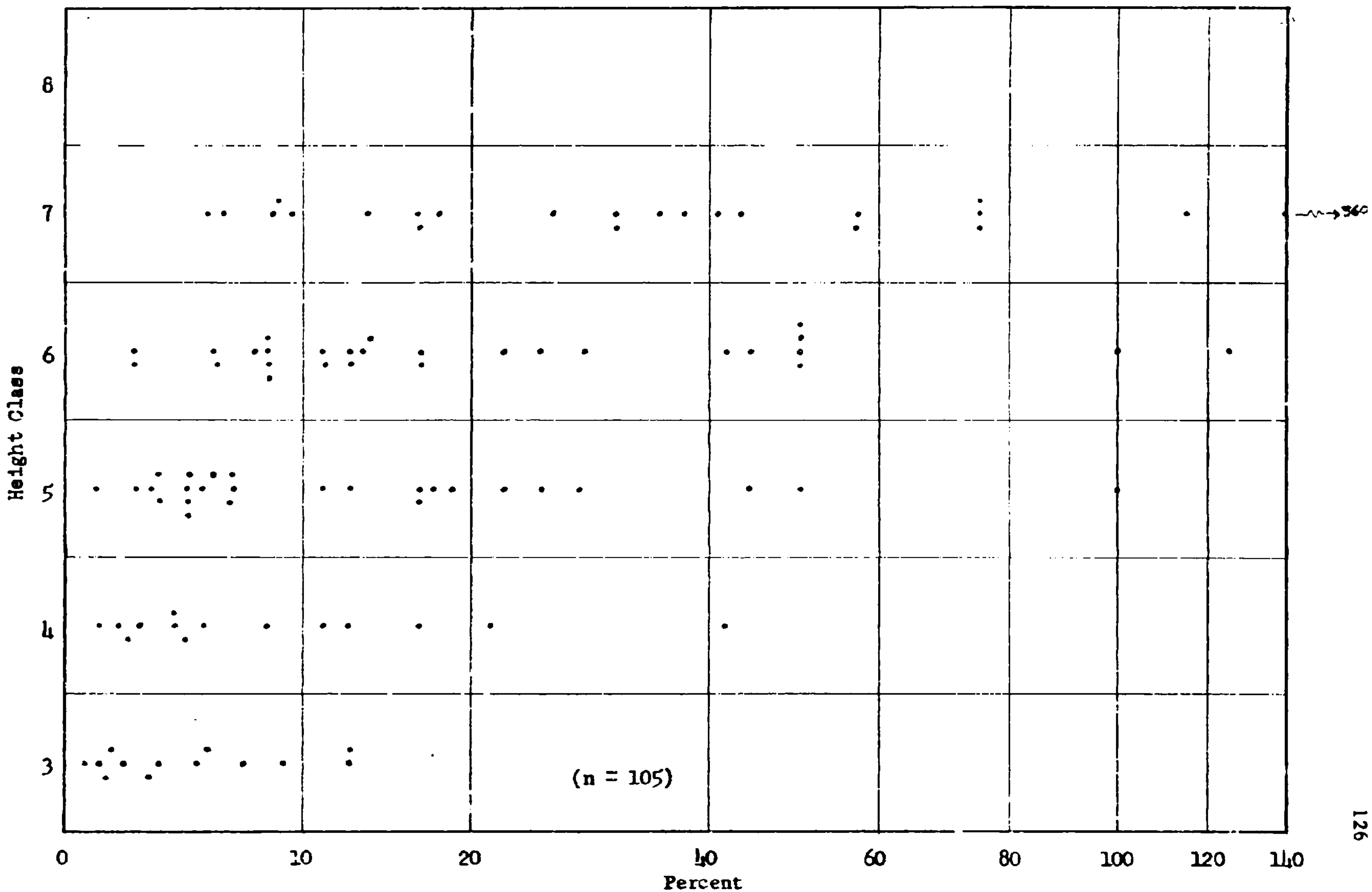

Figure 57. Percent of stems in field samples shown on vegetation diagrams.

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